



MONTHLY NOTICES

OF THE

ROYAL ASTRONOMICAL SOCIETY.

VOL. XXXVII.

February 9, 1877.

No. 4.

WILLIAM HUGGINS, Esq., F.R.S., President, in the Chair.

Geo. Francis Hardy, Esq., Rothbury House, Stroud Green, Finsbury Park, N.;

John Sidney White, Esq., 13 Bolton Gardens, South Kensington, S.W.; and

A. Mason Worthington, Esq., B.A., Sandiway House, Altrincham;

were balloted for and duly elected Fellows of the Society.

REPORT OF THE COUNCIL TO THE FIFTY-SEVENTH ANNUAL GENERAL MEETING OF THE SOCIETY.

Progress and present state of the Society:—

	Compounders.	Annual Subscribers.	Non-resident.	Mathematical Society.	Patroness, and Honorary.	Total Fellows.	Associates.	Grand Total.
December 31, 1875	204	348	5	7	2	566	42	608
Since elected ...	+ 9	+ 20	...	...	...	...	...	...
Deceased ...	- 2	- 7	...	...	- 1	...	...	...
Removals ...	+ 1	- 1	...	...	...	...	...	...
Resigned ...	...	- 6	...	...	...	...	...	...
Expelled ...	...	- 1	...	...	...	...	...	...
December 31, 1876	212	353	5	7	1	578	42	620

REPORT OF

The Report of the Auditors not having been received at the following copy of the Treasurer's signed Report submitted to

Mr. Whitbread's Account as Treasurer of the Royal

RECEIPTS.

	£	s.	d.	£	s.	d.
Balance at Bankers', Dec. 31, 1875	548	18	9			
In hand of Secretary of Library Committee:						
On account of Library Expenses	32	3	0			
" Turnor Fund	21	0	0			
In hand on Petty Cash Account	13	4	11			
				615	6	8
Dividend on £3,700 Consols	55	0	9			
" £5,200 New 3 per Cents.	77	7	0			
" £4,000 Consols	59	5	0			
" £5,200 New 3 per Cents.	77	0	6			
				268	13	3
Received on account of subscriptions:						
Arrears of contributions	106	1	0			
237 Contributions for 1876	497	14	0			
On account of ditto	2	0	0			
28 Admission Fees	60	18	0			
20 first Contributions	32	11	0			
				699	4	0
11 Composition Fees				231	0	0
Sale of publications at Society's Rooms	52	18	8			
" " Williams & Norgate's	23	1	0			
				75	19	8
Balance of Horrox Memorial Fund				38	15	0
Bequest of the late T. C. Janson, Esq., to the Lee Fund				200	0	0
Bequest of the late R. C. Carrington, Esq., £2,000 Consols, transferred to the Society's account, at 94				1,880	0	0
Due to Assistant Secretary, on Petty Cash Account, Dec. 31, 1876				2	18	8

£4,011 17 3

SAM. CHAS. WHITBREAD,
Treasurer.

THE TREASURER.

time of the revision of the Annual Report of the Council, the the Auditors is herewith appended.

Astronomical Society, from Dec. 31, 1875, to Dec. 31, 1876.

EXPENDITURE.

Salaries :—					£	s.	d.	£	s.	d.
Editor of <i>Monthly Notices</i> , 5 quarters	...	...	...	...	75	0	0			
Assistant Secretary, 5 quarters	...	...	...	...	187	10	0			
								262	10	0
Income Tax and House Duty	...	...	...	...	...	...	...	5	5	0
Fire Insurance	...	...	...	...	...	...	...	7	16	6
Printing :—										
Spottiswoode & Co.	...	...	...	...	364	8	0			
Hazell, Watson, & Viney	...	...	...	...	187	12	0			
Holdgate Brothers, Printing Plates...	...	...	...	...	18	5	0			
								570	5	0
Lithography, Engraving, &c. :—										
Chatham School of Photography	...	...	...	...	5	10	0			
W. H. Wesley	...	...	...	...	51	2	0			
								56	12	0
Binding and Stitching: J. Rumfitt	...	...	...	...	...	...	...	39	17	3
Library expenses, binding books, &c.	...	...	...	...	...	...	...	138	14	6
Turnor Fund: books purchased during year	...	...	...	...	...	...	...	48	16	3
Miscellaneous :—										
House expenses	...	...	...	...	28	7	7			
Wages...	...	...	...	...	23	17	0			
Stamps and postage	...	...	...	...	49	10	8			
Carriage of books and parcels	...	...	...	...	8	8	2			
Stationery and office expenses	...	...	...	...	8	6	0			
Expenses of meetings	...	...	...	...	17	15	6			
Coals and gas...	...	...	...	...	74	19	9			
Mrs. Jackson-Gwilt's Annuity	...	...	...	...	8	19	0			
Fittings in Library &c.: Whitechurch Bros.	...	...	...	...	5	14	6			
Sundries	...	...	...	...	20	19	8			
Bankers' commission &c.	...	...	...	...	0	0	6			
New cheque-book	...	...	...	...	0	8	4			
								247	6	8
Investments :—										
Purchase of £300 Consols, at 96 $\frac{3}{8}$, including commission...	...	...	...	...	289	10	0			
Purchase of £200 Consols, at 95 $\frac{5}{8}$, including commission...	...	...	...	...	191	10	0			
								481	0	0
Carrington Legacy of £2,000 Consols, transferred to Society's account, at 94	...	...	...	...	...	...	...	1,880	0	0
Balance at Bankers', Dec. 31, 1876	...	...	...	...	238	1	10			
In hand of Secretary of Library Committee on account of Library Expenses	...	...	...	...	13	8	6			
On account of Turnor Fund	...	...	...	...	22	3	9			
								273	14	1
								£4,011	17	3

SAM. CHAS. WHITBREAD,
Treasurer.

Vol.	At Society's Rooms.	At Williams & Norgate's.	Vol.	At Society's Rooms.	At Williams & Norgate's.
XXVII.	2	...	XXXIII.	136	4
XXVIII.	82	2	XXXIV.	108	4
XXIX.	68	2	XXXV.	36	4
XXX.	78	4	XXXVI.	71	2
XXXI.	118	1	Index to <i>Monthly Notices</i> }	612	1
XXXII.	150	4			

In addition to the stock in hand of the volumes of the *Monthly Notices*, there are also a considerable number of separate numbers of almost every volume. These back numbers, although no complete volume can be formed from them, except of Vol. XXXVI., are available for the completion of sets.

Besides the seventy-one bound copies of Vol. XXXVI., a large number of each part are also in stock.

Stock in hand of volumes of the *Memoirs* :—

Vol.	At Society's Rooms.	At Williams & Norgate's.	Vol.	At Society's Rooms.	At Williams & Norgate's.
I. Part 1	3	...	XV.	153	1
I. Part 2	50	...	XVI.	182	...
II. Part 1	61	...	XVII.	159	4
II. Part 2	26	...	XVIII.	161	1
III. Part 1	76	...	XIX.	168	1
III. Part 2	95	...	XX.	164	1
IV. Part 1	90	3	XXI. Part 1	314	...
IV. Part 2	100	3	XXI. Part 2	99	...
V.	115	4	XXI. 1 & 2 (together)	70	1
VI.	135	4	XXII.	166	...
VII.	159	3	XXIII.	162	1
VIII.	138	3	XXIV.	167	2
IX.	146	3	XXV.	180	2
X.	157	1	XXVI.	183	2
XI.	166	1	XXVII.	437	1
XII.	170	...	XXVIII.	400	2
XIII.	184	2	XXIX.	426	1
XIV.	381	3	XXX.	176	...

Vol.	At Society's Rooms.	At Williams & Norgate's	Vol.	At Society's Rooms.	At Williams & Norgate's
XXXI.	159	2	XXXVII.	329	5
XXXII.	181	2	Part 2		
XXXIII.	183	1	XXXVIII.	327	2
XXXIV.	149	36	XXXIX.	313	3
XXXV.	133	2	Part 1		
XXXVI.	212	5	XXXIX.	333	1
(with M.N.)			Part 2		
XXXVI.	18	...	XL.	389	3
(without)			XLII.	404	4
XXXVII.	381	8	Index to		
Part 1			<i>Memoirs</i>	707	5

Since the last anniversary meeting the Assistant Secretary has examined the stock of volumes of the *Memoirs* and *Monthly Notices* with the greatest care, and he has re-arranged it in a more convenient manner for future examinations. In doing this he has found several mistakes in the lettering of the different parcels, which account for some discrepancies between the lists in this and the preceding Report.

Instruments belonging to the Society.

The following is a complete list of the instruments belonging to the Society. The Council have to regret that most of those missing at the date of the last Report are still unaccounted for. It is possible, however, that a few of them may ultimately be traced, and in consequence it would be unadvisable at present to strike them out of the list.

The resolution of the Council "that the Secretaries in every November shall go through the list of the Society's instruments, and send to each person to whom any instrument belonging to the Society has been lent, a circular desiring him to return the instrument to the Society's rooms before the following January meeting, or to make a fresh application for it," has been faithfully carried out. By thus confining the loan of the instruments to one year, subject to renewal if required for a longer period, it is expected that any unexplained loss of instruments will be prevented for the future. The Council have no desire to hasten the return of an instrument when it is still of service to the borrower, but it is very desirable that it should be returned to the Society's rooms as soon as possible when no longer required.

Some interesting notes by Mr. Lecky on several of the instruments may be found on pp. 132-134 of the last Annual Report. The complete list is as follows:—

- No. 1. The *Harrison* clock,
 „ 2. The *Owen* portable circles, by Jones,
 „ 3. The *Beaufoy* circle,
 „ 4. The *Beaufoy* transit instrument,
 „ 5. The *Herschelian* 7-foot telescope,
 „ 6. The *Greig* universal instrument, by Reichenbach and
 Ertel. The transit telescope, by Ultzschneider and
 Fraunhofer, of Munich,
 „ 7. The *Smeaton* equatoreal,
 „ 8. The *Cavendish* apparatus,
 „ 9. The 7-foot Gregorian telescope (late Mr. Shear-
 man's),
 „ 10. The Variation transit instrument (late Mr. Shear-
 man's),
 „ 11. The Universal quadrant, by Abraham Sharp,
 „ 12. The *Fuller* theodolite,
 „ 13. The Standard scale, by Troughton and Simms,
 „ 14. The *Beaufoy* clock, No. 1,
 „ 15. The *Beaufoy* clock, No. 2,
 „ 16. The *Wollaston* telescope,
 „ 17. The *Lee* circle,
 „ 18. The *Sharpe* reflecting circle,
 „ 19. The *Brisbane* circle,
 „ 20. The *Baker* universal equatoreal,
 „ 21. The *Reade* transit,
 „ 22. The *Matthew* equatoreal, by Cooke,
 „ 23. The *Matthew* transit instrument,
 „ 24. The *South* transit instrument,
 „ 25. A Quadrant, by Bird (formerly belonging to Captain
 Cook),
 „ 26. A Globe showing the Precession of the Equinoxes.

The *Sheepshanks* collection :—

- „ 27. (1.) 30-inch transit instrument, by Simms, with
 level and two iron stands.
 „ 28. (2.) 6-inch transit theodolite, with circles divided
 on silver; reading microscopes, both for altitude
 and azimuth; cross and siding levels; magnetic
 needle; plumbline; portable clamping foot and tripod
 stand.
 „ 29. (3.) $4\frac{6}{10}$ -inch achromatic telescope, about 5 feet 6
 inches focal length; finder; rack motion; two other
 micrometers; one terrestrial and ten astronomical
 eyepieces, applied by means of two adapters, with
 equatoreal stand clock movement.
 „ 30. (4.) $3\frac{1}{4}$ -inch achromatic telescope, with equatoreal
 stand; double-image micrometer; one terrestrial
 and three astronomical eyepieces.
 „ 31. (5.) $2\frac{3}{4}$ -inch achromatic telescope, with stand;
 one terrestrial and three astronomical eyepieces.

- No. 32. (6.) $2\frac{3}{4}$ -inch achromatic telescope, about 30 inches focal length; one terrestrial and four astronomical eyepieces. This instrument was lent to the late Rev. J. Cape, and is believed to be lost.
- „ 33. (7.) 2-foot navy telescope.
- „ 34. (8.) A transit instrument of 45 inches focal length; with iron stand, and also Ys for fixing to stone piers; two axis levels.
- „ 35. (9.) Repeating theodolite, by Ertel, with folding tripod stand.
- „ 36. (10.) 8-inch pillar sextant, by Troughton, divided on platinum, with counterpoise stand and artificial horizon.
- „ 37. (11.) Portable zenith telescope and stand, $2\frac{3}{4}$ -inch aperture and 26 inches focal length; 10-inch horizontal circle and 8-inch vertical circle, read to 10'' by two verniers to each circle.
- „ 38. (12.) 18-inch Borda repeating circle, by Troughton, $2\frac{1}{8}$ -inch aperture and 24 inches focal length; the circles divided on silver, the horizontal circle being read by four verniers, and the vertical circle by three verniers, each to 10''.
- „ 39. (13.) 8-inch vertical repeating circle, with diagonal telescope, by Troughton and Simms; circle divided on silver, reading to 10''; a 5-inch circle at eye-end reading to single minutes; horizontal circle 9 inches diameter in brass, reading to single minutes.
- „ 40. (14.) A set of surveying instruments, consisting of a 12-inch theodolite for horizontal angles only, reading to 10''; two sets of adjusting plates; tripod stand with enclosed telescope; a deal box with heavy stand for theodolite; a box containing the Y piece of level; two large and three small ground-glass bubbles divided; a box containing level collimator, object-glass $1\frac{5}{8}$ -inch diameter and 16 inches focal length; micrometer eyepiece, comb, and wires.
- „ 41. (15.) Level collimator with object-glass $1\frac{7}{8}$ -inch diameter and 16 inches focal length; stand, rider-level, and fittings.
- „ 42. (16.) 10-inch reflecting circle, by Troughton, reading by three verniers to 20''; counterpoise stand; artificial horizon with mercury; two tripod stands.
- „ 43. (17.) Hassler's reflecting circle, by Troughton, with counterpoise stand.
- „ 44. (18.) 6-inch reflecting and repeating circle, by Troughton and Simms, contained in three boxes, two of which form stands. The circle is divided on silver, and is read to single minutes; two inside arcs divided to single degrees, 150 degrees on each side; artificial horizon and mercury.

- No. 45. (19.) 5-inch reflecting and repeating circle, by Lenoir, of Paris.
- „ 46. (20.) Reflecting circle, by Jecker, of Paris, 11 inches in diameter, with one vernier reading to 15".
- „ 47. (21.) Box sextant; reflecting plane and level.
- „ 48. (22.) Prismatic compass, by Troughton and Simms.
- „ 49. (23.) Mountain barometer.
- „ 50. (24.) Prismatic compass, by Thomas Jones, mounted with a cylindrical lens.
- „ 51. (25.) Ordinary $4\frac{1}{2}$ -inch compass with needle.
- „ 52. (26.) Dipping needle, by Robinson.
- „ 53. (27.) Compass needle, mounted for variation.
- „ 54. (28.) Magnetic intensity needle, by Meyerstein, of Göttingen; a strongly fitted brass box with heavy magnet; filar suspension.
- „ 55. (29.) Box of magnetic apparatus.
- „ 56. (30.) Hassler's reflecting circle, by Troughton; a $10\frac{1}{2}$ -inch reflecting and repeating circle, with stand and counterpoise, divided on platinum with two movable and two fixed indices; four verniers reading to 10".
- „ 57. (31.) Box sextant and glass plane, artificial horizon, by Troughton and Simms.
- „ 58. (32.) Plane $2\frac{3}{8}$ speculum; artificial horizon, and stand.
- „ 59. (33.) $2\frac{1}{2}$ -inch circular level horizon, by Dollond.
- „ 60. (34.) Artificial horizon, roof, and trough; the trough $8\frac{1}{4}$ by $4\frac{1}{4}$ inches.
- „ 61. (35.) Set of drawing instruments, consisting of 6-inch circular protractor and common protractor, T-square; one beam compass.
- „ 62. (36.) A pentagraph.
- „ 63. (37.) A noddy.
- „ 64. (38.) A small Galilean telescope, with object-glass of rock crystal.
- „ 65. (39.) Five levels.
- „ 66. (40.) 18-inch celestial globe.
- „ 67. (41.) Varley stand for telescope.
- „ 68. (42.) Thermometer.
- „ 69. (43.) Telescope, with the object-glass of rock crystal.
- „ 70. Portable equatoreal stand.
- „ 71. Portable altazimuth tripod.
- „ 72. Four polarimeters.
- „ 74. Registering spectroscope, with one large prism.
- „ 76. Two five-prism direct-vision spectroscopes.
- „ 78. $9\frac{1}{4}$ -inch silvered-glass reflector and stand, by Brown-ing.
- „ 79. Spectroscope.
- „ 80. A small box, containing three square-headed Nicol's prisms; two Babinet's compensators; two double-

image prisms ; three Savarts ; one positive eyepiece, with Nicol's prism ; one dark wedge.

- No. 81. A back-staff, or Davis' quadrant.
- „ 82. A nocturnal, or star dial.
- „ 83. An early non-achromatic telescope, of about 3 feet focal length, in an oak tube made in one piece. The words "Samuel Scatliffe, Londini, Fecit," are engraved on the draw-tube of the eyepiece.
- „ 84. A Hollis observing chair.

Nos. 73, 75, and 77 have been removed from the list by order of the Council.

The following instruments are lent, during the pleasure of the Council, to the several parties undermentioned :—

- No. 2. The *Owen* portable circle, No. 1, to Mr. Lecky.
- „ 4. The *Beaufoy* transit instrument, to the Observatory, Kingston, Canada.
- „ 12. The *Fuller* theodolite, to the Director of the Sydney Observatory.
- „ 22. The *Matthew* equatoreal, to Mr. Brett.
- „ 78. The $9\frac{1}{4}$ -inch silvered-glass reflector, to Mr. Neison.
- „ 81. *Davis'* quadrant, to Mr. Lecky.

From the *Sheepshanks* collection :—

- „ 27. No. 1, to the Astronomer Royal.
- „ 31. No. 5, to Mr. Birt.
- „ 34. No. 8, to the Rev. Professor Pritchard.
- „ 35. No. 9, to the Sydney Observatory.
- „ 61. No. 35, 6-inch circular protractor, to Mr. Birt.
- „ 67. No. 41, to the Rev. Professor Pritchard.
- „ 69. No. 43, to Dr. Huggins.

The *Herschelian* 7-foot telescope and the *Cavendish* apparatus were lent to the Science and Art Department of the Committee of Council on Education in April last, for exhibition in the Special Loan Collection of Scientific Apparatus, at the South Kensington Museum. These instruments have now been returned to the Society, the Exhibition having been closed in December last.

The following is the list of missing instruments :—

- No. 11. Universal quadrant, by Abraham Sharp.
- „ 22. The *Reade* transit.
- „ 32. *Sheepshanks* instrument, No. 6.
- „ 64. „ „ „ 38.
- „ 66. „ „ „ 40.
- „ 68. „ „ „ 42.
- „ 71. Portable altazimuth tripod.

The Janson and Carrington Bequests.

During the past year the Treasurer has received the sum of two hundred pounds from the trustees of the estate of the late Mr. T. C. Janson, formerly a Fellow of our Society, who died in 1863. This legacy, which became payable on the death of his widow, has been added to the Lee Fund, in conformity with the wishes of the testator.

The interest which our late Fellow, Mr. R. C. Carrington, took in the welfare of our Society and in the promotion of practical astronomy, remained to the last, although in his later days ill-health prevented him in a great measure from continuing his active services in the cause of our science. By his will, drawn up a few months before his death, he bequeathed to the general fund of the Society the munificent legacy of 2,000*l.* Consolidated Annuities, free of duty, which was transferred by his representatives to the Society's Consols account in December last. Valued at 94 per cent., the market price on the day of transfer, the amount credited to the Society in the Treasurer's Report is 1,880*l.*

The Library.

On reference to the Treasurer's Report, the Fellows will perceive that the Council has devoted a considerable sum during the past year towards the improvement of the condition of the Library. The principal item of expenditure has been incurred on account of the large amount of binding required to be done for the orderly arrangement of the books, more especially of the serial publications. Hitherto, owing to the usual practice of not binding most of the serials, and to the confined space devoted to the Library at Somerset House, it was scarcely possible to preserve that order in the classification of subjects which ought to exist in such a valuable collection of astronomical and other scientific works as that belonging to the Society, and many of the advantages to be derived from a free circulation of the books were consequently lost to the Fellows. This was particularly felt in the case of the *Transactions* of foreign academies, and in the numerous scientific serials, which were often not easily found when required. On the removal of the Society to Burlington House, one of the early acts of the Council was the appointment of a Sub-Committee, with full authority to reorganise the Library, and to devise the necessary measures for placing it in an efficient condition. A liberal sum was at once voted by the Council to defray the expense of binding those works which immediately required it for their preservation, and further grants for the same purpose have been continued at intervals.

There is still a large amount of binding necessary before

the full improvement in the Library arrangements will be seen, but a cursory glance over the various classified shelves is sufficient to exhibit the satisfactory transformation made in this important section of the Society's operations. The attention of the Sub-Committee has also been directed to the numerous *lacunæ* in the sets of serial publications, and fortunately they have succeeded in filling up many of them; but there is still much more to be done in this direction, as it is a notable fact that the library does not contain a perfect set of the *Astronomische Nachrichten*, and some other astronomical serials which are continually required for reference. A large number of valuable works have been added during the year from various sources. Besides the usual amount of presents received, the Library has been enriched by extensive purchases through the Turnor Fund, which had accumulated in February last to 164*l.*; by the munificent gift from the representative of our late honorary member, Miss Sheepshanks; by Lord Lindsay's presentation of four folio and ten quarto manuscript volumes of Mr. Carrington's observations of Sun-spots; by the Rev. F. Howlett's present of five large volumes of drawings of Sun-spots made by him in the course of the preceding seventeen years; and by Mrs. Selwyn's gift of a series of paper prints from the solar negatives of the Sun taken at Ely in the years 1863-1873, under the superintendence of the late Professor Selwyn.

As the result of the greater facilities afforded to the Fellows by the present arrangement of the Library, the Council are gratified in being able to report that the circulation of books during the past year is considerably in excess of that of former years.

The general rules and regulations for the management of the Library, drawn up by the Council in 1837, having become practically obsolete and unknown to the majority of the Fellows, new regulations have been prepared with great care in the interests both of the Society and of the Fellows. It is hoped that those who are in the habit of consulting the books in the Library will assist the Council in carrying these rules out in their strict integrity. For the convenience and information of the Fellows the new regulations are inserted below.

Regulations for the Library.

I. A book shall be kept in which shall be entered the title of every book borrowed, the name of the Fellow borrowing the same, and the date on which it is lent; and that an acknowledgment in writing shall be given at the time of borrowing any book from the Library; and on the return of such book the Assistant Secretary shall insert opposite to the entry the date on which the book has been returned, and give in writing an acknowledgment of its return. And if, on the return of such book, the Assistant Secretary shall perceive that it has sustained

any damage during its loan, he shall make a note of the particulars, and report the same to the Library Committee.

II. No book shall be lent before its presentation to the Society shall have been announced at one of the ordinary meetings, unless the President or either of the Secretaries give permission to that effect.

III. A list of books and periodicals, which are not to be taken out of the Library without special permission from the Council, shall be placed in a conspicuous position in the Library.

IV. No Fellow shall be permitted to have more than ten volumes from the Library in his possession at any time without special permission from the Council.

V. In case any book borrowed from the Library shall be lost or damaged, the Fellow by whom it was borrowed shall be held responsible for the loss or damage; and, if belonging to any set, shall be held liable to make good the set to the satisfaction of the Council.

VI. All books shall be returned to the Library on or before the second Friday in November in each year. It shall be the duty of the Assistant Secretary, before the November meeting, to forward to all Fellows of the Society who, according to the entries in the book kept for that purpose, have any books belonging to the Society in their possession, a letter requesting that all such books be returned to the Society on or before the day of the November meeting.

VII. If any Fellow signify to the Assistant Secretary that he requires a book already taken out from the Library, it shall be the duty of the Assistant Secretary to make application to the Fellow who has borrowed it, and he shall return it, free of expense, within a month from the day on which application was made for it by the Assistant Secretary.

VIII. Every Fellow who shall have transgressed any of the above regulations shall be precluded from borrowing any book from the Library until he receives the special permission of the Council.

IX. No person who is not a Fellow of the Society shall be permitted to borrow any book, or to have access to the Library, without permission in writing from the President or one of the Secretaries.

Publications of the Society.

Volume XLI. of the *Memoirs*, containing collected accounts of physical observations of total eclipses of the Sun, which has now been upwards of five years in preparation, will, the Council have reason to hope, shortly be in the hands of the Fellows. A copy of a considerable portion of the volume which is already printed is placed in the Library, where it may be consulted by anyone interested in the subject. The volume will contain a large

amount of classified information relating to solar eclipses observed down to 1874. It will extend to about 600 pages, and will be illustrated by woodcuts, and seventeen quarto plates, eight of which are devoted to the illustration, on a large scale, of the coronal structure visible in the photographs of the eclipse of December 11, 1871.

Nearly all the communications to the Society during the past year have been printed in the *Monthly Notices*, which still continue to be a favourite medium for the early dissemination of astronomical papers. Special attention may be directed to several valuable communications by the Astronomer Royal, the results of the extra-meridional work at the Royal Observatory. The most important of these contains the results of the recent observations of the displacement of the lines in the spectra of the stars and planets, with the object of determining the motions of certain stars and of *Venus* in the line of sight, and for the rotation of the Sun and *Jupiter*. The method employed by Dr. Huggins has been adopted in these observations with some modifications, and his conclusions have been borne out by the Greenwich observations. An interesting paper by Professor Langley on the measurement of the direct effect of Sun-spots on terrestrial climates, and one by Professor Newcomb, on a hitherto unnoticed apparent inequality in the longitude of the Moon, have been communicated to the Society and printed in the *Monthly Notices*. Many other important communications have been made to the Society, including papers by Mr. Knobel, Professor Harkness, Mr. Darwin, Mr. Knott, and others.

The volumes of the *Memoirs* and the separate numbers of the *Monthly Notices* as they appear are distributed to the principal public observatories and scientific libraries throughout the world at a considerable expense to the Society. Twenty-five copies of the *Monthly Notices* are also forwarded to the Hydrographer of the Admiralty for gratuitous distribution among the different surveying vessels. The Council trust that this liberality on the part of the Society in the interests of science, will ensure a corresponding interchange of all the scientific publications issued by our own Government, as well as by the various home and foreign institutions on our free distribution list.

It ought, however, to be remarked here that the usual complimentary copies of some Government publications, which for many years have been presented to the Society, will probably be discontinued in conformity with the terms of a recent Treasury Minute; and that if this be the case copies of such a work as the *Nautical Almanac* can in future be obtained for our Library only by purchase. The question is of slight importance if it referred merely to the *Nautical Almanac*, which is published at a small charge; but were this Minute carried out on the plea of economy, without some relaxation with respect to more expensive Government scientific publications, such as the *Greenwich Observations*,

or the *Cape Observations*, it would be the greatest retrograde step in the relation of Government to science that has ever occurred.*

Some of the Fellows may probably be unaware that the *Memoirs* of the Society are presented gratuitously to them on application to the Assistant Secretary, at Burlington House, either by themselves or their accredited agents, within three years of the date of publication.

OBITUARY.

The Council regret that they have to record the loss by death of the following Fellows during the past year:—

Honorary Member:—Miss Anne Sheepshanks.

Fellows:—Rear-Admiral A. B. Becher.
C. H. H. Cheyne, Esq., M.A.
Lieutenant Cyril Corbet, R.N.
Thomas Dell, Esq.
Rev. John Edwards, M.A.
Charles Lambert, Esq.
Rev. Robert Middlemist, M.A.
Rear-Admiral H. C. Otter, C.B.
G. W. Roberts, Esq.
Chevalier François de Rosaz.
Lient-Colonel Alexander Strange, F.R.S.
Andrew Yeates, Esq.

Our late Honorary Member, Miss ANNE SHEEPSHANKS, who died at an advanced age a few days before the last anniversary meeting, was one of the many patrons of our science whose memory will remain associated with the history of astronomy in the nineteenth century. The sister and companion of the late Rev. Richard Sheepshanks, of whom she was the senior by five years, she shared the interest which he always took in the progress of astronomy, and especially in the proceedings of this Society, in the administration of which he had laboured so faithfully and so successfully to within a short period of his death. Through this admiration of her brother's love for astronomical work, and also as a record of her own affection for his memory, Miss Sheepshanks determined to devote a considerable portion of her property for the promotion of the study of his favourite

* It will be gratifying to the Fellows to be informed that since this Report was read at the Annual Meeting, the Astronomer Royal has received an official communication from the Secretary of the Treasury, dated February 9, 1877, stating that the Stationery Office has been authorised to hand over the whole impression of the *Greenwich Observations* every year for gratuitous distribution according to the discretion of the Astronomer Royal, subject only to an annual report of the details of the distribution being submitted to the Treasury.—E. DUNKIN.

science in the University of Cambridge. To carry out her views in the most advantageous manner, she sought the advice and assistance of some of her brother's most intimate scientific friends, by whom she was guided in her decision as to the appropriation of her intended gift. She ultimately resolved to transfer the munificent donation of 10,000*l.* Consols into the joint names of the Master, Fellows, and Scholars of Trinity College and Mr. (now Sir George B.) Airy, the interest of which was to be devoted to the advancement of astronomical and kindred sciences in the University. A Grace, accepting the gift, was passed by the Senate at the Congregation held on the 9th of December, 1858. It was finally recommended by Dr. Whewell, Master of Trinity College, and Mr. Airy, on the part of Miss Sheepshanks, and agreed to by the Vice-Chancellor and other University authorities, that one-sixth part of the amount, producing 50*l.* per annum, should be specially devoted to the foundation of an astronomical scholarship at Trinity College, to be named the "Sheepshanks Exhibition," and that it should be open to the undergraduates of any of the colleges, the exhibition being awarded, after examination, to the candidate best versed in theoretical and practical astronomy. Bearing in mind the long connection of Mr. Sheepshanks with Trinity College as one of its Fellows, it was considered that the endowment of this permanent astronomical exhibition would be a most appropriate memorial to him in his own University, and at the same time be subject to the care of his own College. Though the Sheepshanks Exhibition is open to the whole University, it has been practically confined to Trinity College, and it has been generally given to one of its undergraduates, who subsequently attained the high position of senior wrangler. The first examination took place in 1859. The exhibition is tenable for three years, on condition that the holder shall keep, by residence, every University term during that time. The interest of the remaining five-sixths of the donation has been reserved to be applied, as required, for the promotion of astronomy, terrestrial magnetism, and meteorology, in connection with the Cambridge Observatory, either in the payment of the stipends of the assistants and computers, or in the purchase of instruments.

In 1860, an additional sum of 2,000*l.* was placed by Miss Sheepshanks into the hands of Mr. Airy to provide a fund for the purchase of a new transit-circle for the Cambridge Observatory. Circumstances having prevented the immediate erection of the instrument, Mr. Airy, with the donor's consent, transferred the amount, with its accumulated interest, to the Vice-Chancellor in the beginning of 1863, a Grace having passed the Senate for its acceptance on the 12th of March of that year. From this second act of beneficence on the part of Miss Sheepshanks, the Cambridge Observatory has been enriched by the excellent meridian-circle, which was constructed by Mr. James Simms, and mounted in the latter part of 1870. It is a first-class meridional instrument, and compares favourably with those

at other public observatories. It is furnished with an object-glass of eight inches aperture, and is provided with two graduated circles of three feet in diameter, one fixed and the other movable. It has also two collimating telescopes, as in the Greenwich transit-circle, each of six inches aperture, which can be directed on each other through the central cube of the instrument. In its construction generally, advantage has been taken of many recent improvements in this class of instruments.

Miss Sheepshanks, after the sudden death of her brother in 1855, lived a very retired life at her residence at Reading, where she died on February 8, 1876, aged eighty-six years. The Fellows of the Society are greatly indebted to her representative, the Rev. Thomas Sheepshanks, for his spontaneous and valuable donation to our Library of 161 separate works, consisting of 192 volumes, forming a portion of the library of the late Rev. Richard Sheepshanks. Many of these works are extremely rare, and of considerable pecuniary value. The title of each work may be found in the list of presents attached to the supplementary number of Vol. XXXVI. of the *Monthly Notices*. A box containing a large number of letters on scientific subjects, received by Mr. Sheepshanks from several distinguished astronomers, together with other correspondence on some controversial matters, has also been presented to the Society, at the request of the Secretaries. These have been sorted and arranged, and it is the intention of the Council to have them bound in an orderly manner for easy reference.

E. D.

Rear-Admiral ALEXANDER BRIDPORT BECHER was the son of Captain A. Becher, R.N., an officer of high scientific attainments. He was born in the year 1796. He entered the Royal Naval College in 1810, and in November 1812 he joined the *Barham*, 74, Captain Spanger, with whom he served as master's mate. This ship was attached to the Channel Fleet, then engaged in the blockade of Brest, from which it was detached to take a large convoy of ships to and from the West Indies. After serving a short time in the *Cordelia*, a 10-gun brig, in the Channel, he joined Commodore Owen for active service on the lakes of Canada during the American War; but on peace taking place soon afterwards, he was transferred to the surveying party under the command of Captain W. F. Owen, brother of the Commodore. This officer was in 1815 commissioned to survey the Canadian Lakes and the River St. Lawrence. Young Becher entered heartily into this work, for which he was exactly suited, the survey having been carried on by a large party afloat in summer, and on the ice in winter, and he has remarked that "he took his full share of the ice work, and had as many duckings from breaking through the ice as anyone of the party." In 1818 he joined the *Superb*, 74, at Plymouth, and in September of that year the *Leven*, Captain Bartholomew, with

whom he spent twenty months on scientific service in the Atlantic, determining the longitude of Funchal, rock hunting, and in surveying the Azores, a part of the African coast, and some of the Cape Verd islands. In 1820 he was appointed to the *Conway*, 26, Captain Basil Hall, on the South American station; and in May 1822 he received his first promotion, as Lieutenant. Between March and December 1839, he served as First Lieutenant in the *Fairy*, surveying vessel, which in the following year foundered during a severe gale in the North Sea, with the loss of Captain Hewett and all his crew. He was made a Commander in 1841, and his last service afloat was undertaken in 1848, to qualify himself for promotion to the next step of rank. Captain Becher thus completed his necessary period of active service as Commander of a surveying vessel on the coast of Scotland. In 1856, he attained the rank of Captain on the Reserved list, and about a year before his death that of Retired Rear-Admiral.

In 1837, Lieutenant Becher communicated to the Society a description of his well-known pendulum artificial horizon, to be attached to a sextant or quadrant for the purpose of observing altitudes by day or night at sea. The special object of the invention was to provide a means of making accurate sextant observations when the real horizon is invisible, either from haze, fog, or other causes. This practical instrument, the result of Lieutenant Becher's nautical skill, requires careful management, and when used by competent observers, it has been proved to be a valuable aid to the nautical astronomer. This extra care required has prevented it from becoming generally adopted in the Service; but the Admiralty acknowledged the ingenuity of the inventor by granting him a moderate pecuniary reward.

In 1823, soon after his return from the South American station, an opportunity was afforded him of employment at the Hydrographic Office. Owing to the recent death of the Hydrographer, an officer was required to arrange and methodise, for easy reference, all the numerous and varied documents preserved in that office, consisting of charts, maps, and plans of every kind, both printed and in manuscript. This entailed the compilation of a general and alphabetical catalogue, with a methodical geographical arrangement of the whole of the papers. For such a work Lieutenant Becher, who happened to be visiting the Admiralty with the object of obtaining an appointment in another ship, appeared to be just the person required; and as he had been accustomed to maritime surveying, and was well acquainted with the construction of charts, this duty was offered to him by the new Hydrographer. He very gladly accepted the laborious task; and his youth and vigour, together with a natural love for the seaman's chart, and a zeal that would not yield to any amount of work, carried him on to the completion of the catalogue, which required three years for its performance. The number of separate entries exceeded 50,000.

Lieutenant Becher's experience of marine surveying, and his general knowledge of hydrographic work, increased in no small degree by his recent duties, led to his permanent appointment as assistant in the Hydrographic Office, in which he remained till his retirement on superannuation in 1865. Twice during this long service he was permitted to go afloat to qualify for rank; but his Admiralty employment was, in each case, kept open for him till his return. While holding the official rank of Chief Assistant to the Hydrographer, Captain Becher also acted as secretary to the Board of Visitors of the Royal Observatory. At the annual visitation on the first Saturday in June of each year, it was his invariable custom to give an official character to his journey from the Admiralty, and many will recollect the pleasant hour passed in his company from Whitehall to Greenwich in the Admiralty barge. He became a Fellow of the Royal Astronomical Society in 1830, and has served on the Council.

Captain Becher took a great personal interest in the success of the *Nautical Magazine*, of which he was the editor from its commencement in 1832 to 1871. It was his chief endeavour to make it a favourite among nautical men, in which they might find hydrographical notices of the discoveries of rocks and shoals, the establishment of light-houses or buoys, and of all matters of interest relating to the Navy or the Mercantile Marine. It was, indeed, a child of his own. He was its guiding spirit during the forty years of his editorship, and he succeeded in obtaining for it a considerable professional reputation, its pages having been always open to the advocacy of any cause which had for its object the promotion of the interests of naval officers, or the amelioration of the condition of our seamen. Many of the most important papers in the Magazine were from his own pen, including translations of foreign hydrographical notices. Captain Becher was often occupied in his leisure hours with other literary work; and in his *Landfall of Columbus* he has apparently succeeded, after much labour, in tracing the actual progress of Columbus among the islands discovered by that great navigator on his way to Cuba.

During the last few years of Admiral Becher's life, failing health compelled him to relinquish all public work; and he lived in retirement, respected by the profession as a kind friend, a zealous and hard-working officer, and a valuable public servant. His promotion to the rank of Rear-Admiral was gratifying to him in his old age, though he did not long enjoy the honour. He died at his residence in London on the 15th of February, 1876, in his eightieth year. His daughter is the wife of Dr. Ellicott, Bishop of Gloucester and Bristol.

E. D.

CHARLES HARTWELL HORNE CHEYNE, M.A., was the eldest son of the Rev. Charles Cheyne, many years Second Master at Christ's Hospital, and maternal grandson of the Rev. T. Hartwell

Horne, the well-known Commentator. He was born on the 1st of May, 1838, and was educated at Merchant Taylors' School, where he continued till he entered St. John's College, Cambridge, in October 1857. He was elected to a foundation scholarship at that college in June 1859, and obtained the B.A. degree in January 1861, as eighteenth wrangler in the Mathematical Tripos.

Soon after taking his degree, Mr. Cheyne contributed to the *Quarterly Journal of Mathematics*, and to the *Messenger of Mathematics*, three original articles on the variation of the Elements in the Planetary Theory. These were followed in October 1862 by the publication of his *Elementary Treatise on the Planetary Theory*, which includes his own investigations, besides all that is important to the student from the works of former writers on the subject. This systematic treatise has become the recognised text-book in Cambridge, and has reached a second edition. Subsequently, in September 1867, Mr. Cheyne published an essay on the *Earth's Motion of Rotation*. In the first part of this work he developed the analogy between the processes for obtaining formulæ for the variation of the elements in the two problems of the Earth's motions of translation and rotation. The methods of investigation are remarkably original, and the subject was presented, for the first time, to English students. The second part contains the application to the questions of Precession and Nutation, and the stability of the Earth's rotation.

In March 1863, Mr. Cheyne was appointed Second Mathematical Master of Westminster School, and in 1864 he proceeded to the M.A. degree. While at Westminster, he published, in conjunction with his colleague, the Rev. C. A. Jones, a collection of *Algebraical Exercises*, progressively arranged, a work which has passed through several editions, and is largely used in our Public Schools. In June 1868, he was elected a Fellow of our Society, and he was a frequent attendant at our meetings. His singularly quiet and unobtrusive disposition prevented him from taking any active part in the proceedings of the Society, for which he was so well qualified; and the pressure of his school duties legitimately interfered with any desire he may have entertained for continuing his astronomical researches.

For the last two years Mr. Cheyne had been in failing health, which ultimately compelled him to resign his mastership in the school. He, however, retained his position there till only a few weeks before his death. He retired to the milder climate of Torquay, where it was hoped that his health would be at least partially restored; but the change was made too late, and he sank from exhaustion within a fortnight of his departure from Westminster, on the 1st of January 1877, at the early age of thirty-eight.

Lieutenant CYRIL CORBET, R.N., was born at Shrewsbury on the 24th of March 1850. He was the youngest of ten children

of Mr. Philip Corbet. At the early age of seven he was sent to Christ's Hospital School, and at twelve he competed for and gained the first cadetship offered to the school by the Board of Admiralty. He entered the Royal Naval College at Portsmouth in December 1862, becoming a midshipman in March 1864, when he joined the *Prince Consort*, Captain Willes. In December 1869, while serving in the *Pallas*, he was made a Sub-Lieutenant, and in the same year he gained the "Beaufort Testimonial," awarded to the officer who obtained the highest number of marks in the examinations of the year. In March 1870, he was appointed to the *Zealous*, flag-ship in the Pacific, and on the 30th of December 1872, he was gazetted Lieutenant. While serving in this ship his natural geniality and kindness of disposition made him a great favourite with both officers and men. The record of many of the incidents of their three years' cruise along the American shores and islands in the Pacific has appeared in *Our Journal in the Pacific*, to which Lieutenant Corbet made several contributions, more especially the chapter relating to an interesting adventure in the wilds of British Columbia.

On the return of the *Zealous* to England in 1873, Lieutenant Corbet was requested by the Admiralty to join a select number of officers who had volunteered for service in connection with the observation of the Transit of *Venus* in December of the following year. He most willingly accepted this duty, and, in consequence, he proceeded to the Royal Observatory to receive the necessary instruction in the use of the various instruments required for the observations. Into this preliminary work he entered with the utmost energy and zeal, and soon became practically conversant with the methods of making and reducing the observations. His steady attention to his duties at the Observatory was the cause of his selection for the important post of chief observer at the second station in Kerguelen Island. For a position of trust of this nature, his high principle, and earnest, thoughtful, and devoted character peculiarly fitted him. He was fully convinced of the importance of this charge, and during his leisure hours at the Royal Naval College at Greenwich he was ever improving his acquaintance with the theory of the observations which he would be required to make at his distant station.

In addition to the appointment as chief observer at the second Kerguelen Station, Lieutenant Corbet was also entrusted with the care of the chronometers especially employed for determining the difference of longitude between the Cape Observatory and Kerguelen, and for the connection of the various stations in the South Indian Ocean. Sailing from England for the Cape of Good Hope in May 1874, in charge of the first detachment of observers, he was ever at work throughout the voyage, as well as during his stay at the Cape, perfecting himself in calculations and observations, or superintending the

necessary preparations in the dockyard at Simons Bay. He appeared to throw his whole soul into the duties he had undertaken, and his persevering and cheerful labour was a great encouragement to others, as well as being most valuable in itself.

On the day of the transit he was fortunate in obtaining an accurate observation of the first internal contact, the faint light streak around *Venus* being in perfect contact with the Sun's limb; but clouds prevented observations at the egress. The first two months in Kerguelen were devoted exclusively to the necessary preparations for the important observations on December 8; but during the remainder of his stay in the island he spent many nights in taking his turn at the transit or altazimuth instruments, while the chronometer-runs and longitude calculations well filled up his days. Even on his homeward journey he continued his work, and it was only when he received at Bombay the sad intelligence of the death of his mother, that he was at last forced to discontinue his calculations and to return in all haste to England.

In June 1875, Lieutenant Corbet was appointed to the *Sirius*, commissioned for service on the West Coast of Africa. Having been sent to visit the Governor of the Colony at Loando, he was struck down on the following day by coast fever. He was at once taken to St. Helena, where he died, soon after reaching that island, on the 17th of February 1876. Thus suddenly closed a career full of promise, before he had completed his twenty-sixth year. Honoured and beloved by his fellow-officers and men, they have placed a monument over his remains, as a tribute to his memory, in the cemetery of St. Helena.

Lieutenant Corbet was elected a Fellow of the Royal Astronomical Society on December 10, 1875, little more than two months before his decease. His connection with us was, therefore, of very short duration. The announcement of his premature and sudden death was deeply deplored by his many friends. The simple thoroughness and kindness of his nature caused him to be highly esteemed and beloved by others than his immediate relations and private acquaintances, especially by those with whom he had been officially associated in the Navy, or in connection with the Transit of *Venus* operations both at Greenwich and Kerguelen.

The Rev. JOHN EDWARDS, M.A., of St. Aidan's College, Birkenhead, was ordained by the Archbishop of York in 1856. He was appointed to the rectory of Bradford-cum-Beswick, Manchester, in 1859, which he held till his death. At an early age he became much interested in astronomical science, and, in his later years, became thoroughly versed in its history and standard writers. Frequently he devoted the little leisure at his disposal to astronomical observation, which was always a pleasure to him. Mr. Edwards was a ready and eloquent speaker, and

occasionally he delivered a series of astronomical lectures, remarkable for their simplicity and comprehensiveness. He was elected a Fellow of the Royal Astronomical Society on November 12, 1869. His literary attainments were highly respectable. He had a well cultivated mind, and was intimately acquainted with biblical literature in general, with ecclesiastical history, and with the various controversies of the Church, of all ages. As a parochial clergyman, Mr. Edwards had few equals in the ability of his ministrations, the ardour of his zeal, and the abundance of his labours. He possessed naturally great geniality of spirit, and was singularly affectionate in disposition. His death has therefore been deeply regretted by his clerical brethren, by his personal friends, and by his parishioners. Mr. Edwards died at his rectory at Bradford-cum-Beswick on the 30th of January 1876, at the age of fifty-eight.

The Rev. ROBERT MIDDLEMIST, M.A., was born on February 29, 1808, and was descended from a respectable Northumberland family. He was educated principally by his relative, Mr. Gourley, who was at that time Head Master of the Grammar Schools at Morpeth and Hexham. When quite a youth, he was in the habit of answering mathematical questions given in the *Lady's Diary*, by which means he soon became known by name to some of the leading mathematicians of the day, who were also contributors to the mathematical section of the *Diary*. By one of these, but an entire stranger to him, he was recommended, in 1831, to Lieutenant Stratford, the Superintendent of the *Nautical Almanac*, as a highly-qualified computer and a good mathematician. This led to his engagement as one of several young computers required to perform the calculations of the new and enlarged edition of the *Nautical Almanac* on the greatly improved plan adopted in November 1830 by a Committee appointed by the Council of the Astronomical Society, and afterwards approved by the Lords Commissioners of the Admiralty. Previous to this, the computations of the *Nautical Almanac* were made in different parts of the country, three of the computers residing in Cornwall, and others at Greenwich, Ludlow, Tideswell, &c. Two only of the old computers, Mr. William Dunkin, of Truro, and Mr. Henry Jenkins, of Greenwich, were retained for service in the newly-established office. Mr. Middlemist was one of the first appointed on the staff, and he was therefore engaged on the *Almanac* for 1834, the first of the new series. He was much trusted by Lieutenant Stratford, who had great confidence in his abilities, and he was selected to make the careful comparison and examination of the duplicate calculations; a duty he performed with such patience and fidelity, that Lieutenant Stratford, in the Preface of the *Nautical Almanac* for 1834, remarked that it was impossible to appreciate too highly the manner with which

he executed this most tedious task. Mr. Middlemist joined our Society on March 14, 1834.

After having served for some time as mathematical master in the Royal Naval School, Mr. Middlemist entered Christ's College, Cambridge, in 1838, as an undergraduate. He became a scholar of his college, and graduated as B.A. in January 1842, being 27th Wrangler. For a time he acted as curate to the Rev. J. E. Gretton, of Stamford; but in 1845 he received the important appointment of senior assistant mathematical master in Harrow School, an office which he retained till his death. He was also vicar of Little Linford, Bucks. Though an occasional attendant at our meetings, Mr. Middlemist does not appear of late years to have interested himself much in astronomy, and he has never been a contributor to the *Proceedings* of this Society. While on a visit to his sister at Ramsgate, he was suddenly attacked with inflammation of the lungs, and died there eight days afterwards, on the 11th of January 1877, in the sixty-ninth year of his age. He has left a widow and seven children—six sons and one daughter.

E. D.

Rear-Admiral HENRY CHARLES OTTER, C.B., was born in the year 1807. At the age of fifteen he entered the Navy as a cadet, and obtained his first commission as Lieutenant in 1831. From August 1833 to the end of 1835, he served as a supernumerary Lieutenant in the *Ocean*, 80, and *Howe*, 120, at Sheerness. At this time he gave many indications of his talents as a scientific officer, and much of his leisure time was occupied in perfecting himself in astronomical observing, especially with those instruments which are practically used for surveying purposes. His acquaintance with the principal nautical astronomers, added to his personal attachment to the observing branch of our science, induced him to become a Fellow of the Royal Astronomical Society, to which he was elected on the 11th of November 1842. In March 1844, Lieutenant Otter was appointed to the command of the *Sparrow*, surveying vessel on the coast of Scotland, and thus commenced that active career as a nautical surveyor under the Hydrographic Office, which he continued for a long number of years, commanding in succession the *Avon*, *Porcupine*, *Shamrock*, and other surveying vessels.

Admiral Otter, when a midshipman, had the satisfaction of performing a most gallant act, as by his heroic exertions he was the means of saving the lives of a boat's crew while in extreme danger, and so lately as 1845 he jumped overboard from the *Sparrow* for the purpose of affording assistance to some of his crew who had been capsized. Most of his time till his retirement was spent afloat in the performance of his surveying duties. His successive promotions were to Commander on August 26, 1844; to Captain on September 8, 1854; and to Retired Rear-Admiral on April 1, 1870. He died at Clare Park, Hants, on the 26th of March 1876, aged sixty-eight.

E. D.

GEORGE WALTER ROBERTS was the third and youngest son of the late Mr. Henry Roberts, of Crow Trees, Gomersal, near Leeds, where he was born on February 9, 1846. From early life he took an interest in astronomy, and about the year 1867 he formed a plan of making a series of planetary delineations with a 12-inch reflector, but he was prevented from carrying out his wishes by the wanton destruction of his instrument by a party of drunken roughs. He, however, shortly afterwards erected a new Observatory, which he furnished with a transit instrument, and an 8-inch achromatic telescope, by Wray, equatorially mounted. With this instrument he was accustomed to devote many of his leisure hours to astronomical work, though he was not usually in the habit of publishing his observations. On March 26, 1873, he observed the fourth satellite of *Jupiter* during its transit across the planet's disk as a very intensely black spot, the particulars of the phenomenon being recorded in Vol. XXXIII. of the *Monthly Notices*. A recent change of residence, combined with increasing ill-health, compelled him to relinquish all scientific work. Mr. Roberts, who joined our Society in March 1872, was ever willing to give his assistance in spreading an interest in astronomy in his neighbourhood; and his cultured mind and genial disposition brought him a large circle of personal friends, by whom his loss will be severely felt. He died at his residence in Leeds, on January 19, 1877, in the thirty-first year of his age, leaving a widow and two daughters.

The Chevalier FRANÇOIS DE ROSAZ was a native of Savoy, but the latter part of his life has been spent in England. He was the only son of a gentleman of some position in his native country, and was originally educated for the medical profession; but his tastes inclined to law rather than to medicine, and he eventually became, during the reign of Louis Philippe, a successful advocate in the legal Courts of Paris. Having been a great supporter of the Orleans dynasty, he resolved to leave France after the Revolution, which resulted in his retirement altogether from his profession. He now settled permanently in England, residing alternately in London and at Brighton, where he continued to lead a most active life, devoting nearly his whole time to philanthropic objects, even to within a short period of his death. He was the founder or supporter of seven distinct charities at Montmelian, his native town, and nearly the whole of his large property is ultimately to be reserved for their permanent benefit, and for the foundation of similar charitable institutions at Brighton. M. de Rosaz was naturally a scientific man, and in his leisure hours he was in the habit of making himself acquainted with the practical use of many valuable instruments which he possessed. He was particularly fond of astronomy, and on his election less than three years ago, he expressed to one of the Secretaries his gratification at being admitted in his old

age a Fellow of the Society. His astronomical instruments, which have been the means of affording instruction to many of his friends, are bequeathed to the Museum at Brighton. His death took place rather suddenly in London, on the 21st of September 1876, in his seventy-sixth year. E. D.

Lieutenant-Colonel ALEXANDER STRANGE, F.R.S., was born at Westminster on the 27th of April 1818, and was the fourth son of Sir Thomas Strange. He received his principal education at Harrow. In 1834, at the early age of sixteen, he was appointed to the 7th Regiment of Madras Light Cavalry, and soon after left England for India, where he passed a continued service of twenty-six years, a large portion of which was in connection with the Great Trigonometrical Survey, then under the superintendence of Captain (now Major-General Sir Andrew) Waugh. His abilities, which were of the highest order, attracted the attention of several scientific officers, from whom he received not only valuable counsel, but also practical instruction in the use of astronomical and surveying instruments. His mechanical skill, so advantageously utilised in after years in his designs for improved geodetical instruments, made it obvious to the military authorities that scientific employment was his natural avocation, and that his talents would prove more advantageous to the service if devoted to the scientific branch of the army than if they were permitted to remain dormant in the routine performance of his regimental duty. For a time he studied at the Magnetic and Meteorological Observatory at Simla, then under the charge of Major (now Major-General) Boileau, F.R.S., and in 1847 he received the appointment of second assistant in the Great Trigonometrical Survey, the duties of which exactly corresponded with his taste for astronomical observing. He thus obtained a full scope for the exercise of those peculiar talents for scientific work which he had exhibited from the time of his entry into the service.

Soon after the acquisition of Scinde and the Punjab, the Surveyor-General considered it of great importance that the newly-acquired territory should be connected with the "Great Arc Series" of triangulations, having the Dehra Doon base at the north, and the Sironj base at the south. From the base at Dehra Doon a north-western series was also to be extended to near Attock, where a new base was to be measured. It was likewise resolved that the line of the "Calcutta Longitudinal Series" should be extended from the Sironj base to Kurrachee, to be named the "Great Longitudinal Series," forming, with extensions to other districts of the Indian territory, a perfect gridiron of triangulations. The western section of this operation was commenced at the end of 1848 by Captain Renny (afterwards Major Renny-Tailyour), assisted by Captain Strange and others, commencing from the Sironj base. In the following year, Captain Renny retired from the Survey, after having executed about

eighty miles of triangulation. He was succeeded by Captain Strange, under whose superintendence this important geodetical work was brought to a successful termination. He was assisted by Lieutenant (now Colonel) Tennant, R.E., and a civilian staff. This triangulation was carried over the rugged range of the Aravulli mountains, then across the great Thurr, or desert, to the north of the Runn of Cutch. After crossing the valley of the Indus, the party reached Kurrachee in April 1853, after five seasons of very severe work. Some idea may be formed of the magnitude of this great triangulation by a reference to the actual distances between the commencing and terminal stations. It has been calculated that the series was 668 miles in length, and consisted of 173 principal triangles, covering an area of 20,323 miles. This is also the first example of a true desert being successfully traversed by a great triangulation.

The remarkable energy displayed by Captain Strange in the management of this great surveying work reflected on him the highest credit, and the manner in which the triangulation was effected was fully to the satisfaction of the Surveyor-General. How these field duties were performed by the party, and what obstacles they had to encounter, is thus related by Mr. Clements R. Markham, F.R.S., in his *Memoir on the Indian Surveys*, a work to which the writer is indebted for several of the facts contained in this notice. "The great difficulty, peculiar to this series, was the crossing of the desert. No geodesical operation of the first order had, at that time, ever been conducted in a desert, and experience was therefore totally at fault as to the probable obstacles to be encountered. Stations had to be selected, in the first instance, by an advanced party. At each station a masonry platform had to be erected in a country entirely composed of sand, and destitute of building materials. After this had been accomplished, the main party engaged in taking the final observations, numbering two hundred men, had to be maintained in the desert during a whole season. The desert furnished only three things useful to man or beast, namely, grass, immediately after the rainy season; limited supplies of milk; and brackish, or, more correctly, salt water in deep wells, scattered at wide intervals. The arrangements therefore involved the supply of provisions of every description for two hundred men during several months. * * * Captain Strange's party reached the borders of Scinde, and commenced operations on the 8th of December 1852. The first station was Chortlee, where it was necessary to observe from a tower thirty-seven feet high, the side being twenty-two miles long, and crossed by the Indus. The view was obstructed by a dense *babool* jungle, intersected in many places by sheets of water. It was a tedious task to clear the line, and then it was long before the signal could be made out at the other station of Helaya, twenty-two miles away. After a wearisome detention of twenty-five days, and much painful straining of the eyes, occasional faint glimpses of Helaya were caught, and at length the angle was

satisfactorily observed. At the next station of Kanad there were fresh misfortunes. The tower, thirty-nine feet high, began to emit a cracking sound towards evening, and luckily the great theodolite had not been placed, when one of the angles fell in. At another place the great theodolite narrowly escaped destruction from a hurricane, and was rescued by the desperate efforts of its guardians, amidst the war of the tempest, in a night of inky darkness. Such are the sort of harassing difficulties and delays which form the daily life of the surveyor, but which are ever cheerfully faced and overcome. Captain Strange and his party had their full share; but at length their work was completed, and the last angle of the series was taken at Muggur Peer station on the 22nd of April 1853."

From this time Captain Strange was employed continuously on surveying work, and in June 1854 he was promoted to the rank of Brevet-Major. In the winter of 1853-4 he assisted in the measurement of the base-line at Attock, the place previously selected by the Surveyor-General as the site for the northern base, in company with other chief officers in the Survey. At the conclusion of the measurement, the apparatus was transported to Kurrachee, the selected site for the southern base operations. The principal charge of this second measurement was entrusted to Major Strange, under the general superintendence of Colonel Waugh, the Surveyor-General, who joined the party at Kurrachee on the 6th of December 1854, on which day the measurement was commenced, having been finally completed on the 20th of the following month.

On the retirement, in 1855, of Mr. Peyton from the superintendence of the "Eastern Coast Series," Major Strange was appointed his successor. The surveying work of this "Series" consisted in carrying a chain of triangles over the eastern coast of the Peninsula from Calcutta to Madras, and it proved to be one of the most difficult portions of the whole Survey, owing principally to the unhealthy climate, the general unfavourable state of the atmosphere, an inaccessible country, and, what probably gave the most anxiety, an inefficient native staff. The work was frequently interrupted by one or other of the party being laid low with jungle fever, which produces a great debility, and depression both of the mental and physical powers. In 1857 Major Strange had a very severe attack, which compelled him to seek a more bracing climate for the restoration of his health, and for a time he resided at the Neilgherry Hills. On his recovery, he returned to his duties, and further progress was made in the survey; but on his promotion in 1860 to the rank of Regimental Major, and in accordance with the usual regulations of the Service, he was obliged to retire from the superintendence of the Series, and also from the Survey, after a connection of thirteen years with the Department. He was succeeded in the charge of the "Eastern Coast Series" by the late Captain Basevi. In 1861 Major Strange returned to England, and

soon after retired from the Army with the rank of Lieutenant-Colonel.

The practical experience gained by Colonel Strange during his various surveying operations, naturally rendered his opinion, in connection with the construction of scientific instruments, of great value; for his proved mechanical skill, and his practical knowledge of the use of mathematical, surveying, and astronomical instruments, was equalled by few men in this country. In 1862, the Indian Government, desirous of securing the advantages of such a great experience in instrumental matters, entrusted to Colonel Strange the task of designing and of superintending the construction of a series of massive and standard instruments, of the first order, for the use of the Great Trigonometrical Survey of India, and in 1863 he received the appointment of Inspector of scientific instruments; his duty to consist of examining and testing every instrument purchased in England, and destined for public service in India. For this purpose an observatory was erected at the warehouse of the Store Department of the India Office, in the Belvedere Road, Lambeth. The class of instruments usually inspected under Colonel Strange's personal superintendence, consisted principally of those employed in surveying operations, including telescopes, sextants, theodolites, levelling instruments, barometers, thermometers, and almost every kind of mathematical and drawing instruments. Nearly one hundred different kinds have been examined yearly, and in that time as many as 7,000 instruments, large and small, have passed through his hands for service.

But the principal instrumental work which occupied the attention of Colonel Strange, was that required for the completion of the large surveying instruments ordered for the Indian Survey. These consisted of two zenith-sectors and a great theodolite, by Troughton and Simms; two five-foot transit instruments, and two smaller ones, by Cooke; two twelve-inch vertical transit instruments, by Repsold; two galvanic chronographs for the registration of transit observations, by Secretan; and three astronomical clocks, by Frodsham. The consideration of the best means of construction, of the metal to be employed, the preparation of the working drawings, and the preliminary trials of the different instruments, absorbed a considerable portion of the time devoted by Colonel Strange to his official work. All this was, however, performed without neglecting the general inspection of the smaller class of instruments. The working drawings of the great theodolite were completed as early as May 1862, embracing the most minute details in nine large sheets, accompanied by a voluminous specification.

Colonel Strange joined our Society on the 12th of April 1861, and he was an active member of our Council, and Foreign Secretary, from 1863 to 1873. He was an ardent lover of science for its own sake; and from the date of his return from India, he has been associated in the management of several Societies,

whose objects coincided with his own peculiar habits of thought. He became a Fellow of the Royal Society on the 2nd of June 1864, and was a member of the Council from 1867 to 1869. He was much interested in the Annual Meetings of the British Association, and was a frequent speaker and contributor in Section A. He was also connected with the Meteorological Society and the Society of Arts. Though Colonel Strange was so much occupied with his official work, he had sufficient leisure to enter heartily into any scheme which had for its object the advancement of any branch of science. Most of his communications to our Society have a highly practical value, and relate chiefly to improved methods of instrumental construction. They exhibit evidence of his great technical knowledge of the optician and engineer's workshops, and they all add to his reputation as a mechanician of the highest order. The following are the titles of his principal papers contained in our *Memoirs* and *Monthly Notices*:—"On testing the Vertical Axis of Altazimuth Instruments;" "On a Direct Method of Testing and Adjusting the Equipoise of Altazimuth Instruments;" "On a Proposed Isolated Flange for Conical Axes;" "On Aluminium Bronze as a Material for the Construction of Astronomical and other Philosophical Instruments;" "On a Zenith Sector for the use of the Trigonometrical Survey of India," &c. In his observatory at Lambeth, Colonel Strange was frequently occupied in purely astronomical work, principally with the object of proving the capabilities of his instruments. In consequence of the peculiar, and, to some extent, private, nature of the observations, very few have been published, although some might have been, to the advantage of astronomy. He was known to have made a careful determination of the latitude of his observatory with one of the instruments made for the Indian Survey, and the observations, if judged by the separate results shown by him to the writer, must have been of great excellence.

Colonel Strange was requested to perform the duties of a juror in the International Exhibition of 1862. He undertook this important office with much pleasure, as it was one in which he could bring his practical knowledge to bear on the peculiarities in the construction of the numerous scientific instruments which would come under examination. He served also a similar office in the Paris International Exhibition of 1867. He had very decided opinions on the question of Government endowment of scientific research, but though they were considered by many as somewhat impracticable, yet very few can doubt his own great sincerity in the soundness of the views entertained by him on the subject. The appointment by her Majesty of the "Royal Commission on Scientific Instruction and the Advancement of Science," of which the Duke of Devonshire was Chairman, was, in a great measure, the result of his persistent advocacy of the necessity for increased Government aid for the promotion of scientific research; and, before his

death, he had the satisfaction of knowing that many of his proposals were adopted by the Commission, and recommended to the Government for their consideration.

The health of Colonel Strange was not good for several months before the end came, but the announcement of his death was unexpected, and was received with deep regret by a large circle of scientific friends. He died at the residence of his niece in Onslow Square, London, on the 9th of March 1876, at the comparatively early age of fifty-seven.

E. D.

ANDREW YEATES was the second son of Samuel Yeates, a well-known mathematical and philosophical instrument maker in Dublin. He was born on the 2nd of February 1800. He showed an early inclination to follow his father's business, and during the delivery of a course of lectures in Trinity College, by Sir Humphrey Davy, both father and son were engaged to assist in making the necessary arrangements for the proper illustrations of the lectures. Whilst so employed, young Yeates availed himself of the opportunity thus opened to him for improving his knowledge of the theory and construction of the philosophical apparatus used in the experiments.

When Captain Drummond suggested the idea of applying the brilliant limelight, which has since been known under his name, for rendering distant stations visible, and which has been found so valuable in the operations of the Trigonometrical Survey, he applied to Mr. Samuel Yeates for his aid in the construction of an instrument for showing the limelight to the best advantage. Andrew Yeates, to whom was given most of the responsibility of the work, spared no time in making himself acquainted with all the details required by Captain Drummond. When he saw the great brilliancy of the light, and was informed that the chief object of the invention was the measurement of distant angles of stations made visible by it, though inaccessible, either from being separated by broad channels of water, or from any other cause, and that the object was the construction of an accurate topographical representation of the British Isles, he determined to make himself acquainted with the whole subject, and by perseverance and enquiry, he was able to realise the great importance of the operations of the Ordnance Survey, and of the necessity and value of having instruments of precision for that undertaking. His practical skill in this class of surveying instruments was fully acknowledged in his after life. His anxiety to enlarge his knowledge of the peculiar details of the instruments used for surveying purposes created a greater desire to become acquainted with the construction of larger astronomical instruments, especially those at the Royal Observatory at Greenwich, then consisting chiefly of Troughton's Transit and Mural Circle, Ramsden's Equatoreal, and a few other less noted instruments. He therefore came to England in 1821, and on his arrival in

London he fortunately made the acquaintance of Troughton, with whom he worked several years. In 1833 he was employed at the Observatory, under the superintendence of the great optician, for the readjustment and repair of the instruments—a work which he performed not only to the satisfaction of his employer, but also of the Astronomer Royal, Mr. Pond. Having been for a long time desirous of becoming acquainted with the details of the Greenwich instruments, this work was peculiarly gratifying to him. From this time Mr. Yeates applied himself principally to the manufacture of mathematical and surveying instruments, in which he has introduced many and important improvements, for which he has received honourable mention on various occasions.

Naturally of a studious and retiring disposition, Mr. Yeates was little known by the general public, but he was much esteemed by a large circle of scientific acquaintances as a careful observer, and, as a manufacturer, for the excellency of his instruments. In him they could repose confidence in his ability as a mechanician, and might rely on his assistance, which he was always ready to afford. His health at last failed from a too sedulous application to business, from which he eventually retired, and spent his closing years in the enjoyment of a country life, surrounded by a select circle of valued friends. His death took place on February 16, 1876, having just completed the seventy-sixth year of his age. Mr. Yeates was elected a Fellow of our Society on March 8, 1861. He was also a Fellow of the Royal Microscopical Society, and a Member of the Society of Arts.

PROCEEDINGS OF OBSERVATORIES.

The following Reports of the proceedings of Observatories during the past year have been received by the Council, excepting that of Melbourne, which has been compiled from Mr. Ellery's Report to the Board of Visitors in June last.

Royal Observatory, Greenwich.

The ordinary observations with the Transit-Circle and Altazimuth have been regularly made during the past year, their number being rather larger than usual. For the first three months the readings of the four supplementary microscopes of the Transit-Circle, as well as of the six ordinary microscopes, which had been fitted with new micrometer screws, were systematically taken with every observation, and the comparison of the two sets showed that the screws were sensibly free from periodic error. To eliminate the effect of wear in future, it is proposed to reverse one micrometer in each pair, so that the springs will act in opposite directions. It has recently been discovered that one of the pivots of the Transit-Circle had been much cut, probably by a grain of sand, which might have accidentally fallen on the Y when the instrument was raised. The roughness has been carefully burnished down by Mr. Simms, and a satisfactory determination of the pivot errors has been made after several failures caused by instability of the apparatus.

The Sidereal Standard Clock has been cleaned lately, having shown considerable irregularities of rate, and finally stopped from the effect of dirt in the train.

The Great Equatoreal has been almost entirely devoted to spectroscopic work, the results of which have, to a great extent, been given in the *Monthly Notices*. The motions of 34 stars have been determined in the past year from the displacement of lines in their spectra, the agreement with Dr. Huggins' results being very remarkable, considering the delicacy of the observation; and, as a check on the principle of the method, the displacement has been measured in the case of the Moon and *Venus*, for which the motion is known from other considerations. Determinations have also been made of the displacement due to the rotation of the Sun and of *Jupiter*. No measures have yet been obtained of the lines in the spectra of nebulae, though a preliminary examination has been made of several of them. Observations have been made of the spectra of *Venus*, *Saturn*, and *Neptune*, as well as of some of the brighter variable stars at maximum and minimum, interesting changes having been noted in several cases. No notification of the discovery of the new star in *Cygnus*

on November 24, reached this Observatory till December 9, when the star had become faint, and as the Equatoreal had then been dismantled, it was not found practicable to observe the spectrum till the beginning of this year. In connection with the displacement of the F line in the spectra of stars, measures of the corresponding line of Hydrogen have been made at pressures varying from 4^{mm} to 290^{mm} , which show conclusively that the line expands equally on the two sides as the pressure is increased, the position of its centre remaining unaltered. At the same time, changes have been noted in the relative brightness of the three principal lines of Hydrogen as the tension of the spark and the pressure were varied, the $H\beta$ line alone being visible at the pressure of 0.2^{mm} , which was the lowest at which the spectrum was observed. This work was much delayed by the necessity for extensive repairs to the Crookes air-pump, and was further hindered by the presence, on many occasions, of a complicated spectrum (possibly due to some impurity), which overpowered the ordinary spectrum of Hydrogen. The Sun's chromosphere has been examined on every favourable opportunity, but the prominences have been generally small, and on 30 per cent. of the days of observation were altogether absent.

In consequence of stiffness in its motion, the Great Equatoreal has been examined lately, and the upper pivot has been found to have been much worn by the friction-rollers, whilst the pivots of the latter had "fired." The mischief has been remedied by Mr. Simms, who has effected a great improvement in the movement of the instrument. The only recent alteration to the Spectroscope has been the mounting of the Collimator-object-glass in gymbals, which allow of its being tilted sufficiently to correct the astigmatism of the prisms. This plan has been found to answer perfectly.

A Direct-vision Spectroscope has been recently made by Mr. Hilger on a new plan, in which advantage is taken of a property of the "Half-prism" to obtain great dispersive power with two, or at the most three, "Half-prisms." As this Spectroscope, though on a small scale, appears to be greatly superior both in dispersive power and brightness of spectrum to the large Spectroscope with its train of ten compound prisms, a larger instrument on the same plan is being made by Mr. Hilger for the Royal Observatory, and it is anticipated that, independently of its greater power, it will be found to have some advantages as regards ease of manipulation over the old form.

The past year has been very unfavourable for Solar photography, only 164 days having been sufficiently clear for this purpose, and on 64 of these there was a complete absence of spots, though faculæ were usually present. The areas of all spots and faculæ on the photographs have been measured to the end of 1876, and the determination of their position-angles and distances from the centre of the Sun's disk has been commenced with

Position-micrometer which Mr. Simms has recently made for

the measurement of Solar photographs. With this instrument the areas will be determined at the same time as the Helio-graphic Co-ordinates. Some photographs of the Moon, *Jupiter*, and stars, as well as of the Solar spectrum, have also been taken.

The August meteors were successfully observed; but in November the weather was very unfavourable, and only a few meteors were noted on November 14.

The computations for the Nine-year Catalogue, containing over 2,250 stars, most of which are observed three or more times in each element, are considerably advanced, although last year's observations will have to be included in it. The precessions and star-constants are all computed in duplicate; all the observations up to the end of 1875 are entered, and about half of them reduced to the epoch 1872; all being corrected for inequality in the micrometer screws, which has been a work of some labour.

The volume for 1874 has been lying for some time past at H.M. Stationery Office, ready for distribution, but detained there until the decision of the Treasury is communicated on the question of gratuitous distribution as in past years.* The printing of the volume for 1875 is far advanced, the sections of observations with the Transit-Circle and Altazimuth being complete; and the reductions for 1876 are in a very forward state, notwithstanding the extra work on the Nine-year Catalogue. All the observations with the Transit-Circle are completely reduced to the end of the year. A detailed report on the progress of the reduction of the observations of the Transit of *Venus* is given under that head.

Radcliffe Observatory, Oxford.

The operations of this Observatory during the past year have been generally of the same character as in preceding years.

The volume of the *Radcliffe Observations for 1873*, of which an abstract of the contents was given in the last Annual Report of this Society, was published and circulated in the spring of last year. The following volume for 1874 is now ready for distribution, and will probably be in the hands of many of the Fellows of the Society before the day of the Annual Meeting. Its contents are chiefly a catalogue of 1,544 stars, 108 observations of the Sun, 50 of the Moon, 23 of *Mercury*, 23 of *Venus*, 15 of *Jupiter*, 11 of *Saturn*, 10 of *Uranus*, 6 of *Neptune*, and 5 of Coggia's Comet, S.P.; a catalogue of 24 double stars, many of which have been repeatedly observed, and 16 measures of the disk of *Jupiter*, giving $37''.16$ for the value of the equatoreal diameter at the unit of distance, and $17^{\frac{1}{3}}$ for the ellipticity. In addition, there are several series of observations of Coggia's Comet made with the heliometer, 10 occultations of stars by the Moon, thoroughly reduced, and 39 observations of phenomena

* See Foot Note on page 143.

of *Jupiter's* satellites ; and, finally, a considerable number of observations of shooting stars. The meteorological portion of the volume contains the usual quantity of matter, carefully arranged, and the same labour has been bestowed on the reduction of the observations as heretofore.

The reduction of the astronomical observations for 1875 has been essentially completed for some time, and the printing of the volume has commenced, three half-sheets of the Right Ascensions of stars having been printed.

The weather during considerable portions of the year 1876 was, as is well-known, very cloudy, and the amount of observations may therefore not be quite so great as in preceding years, though it does not fall very far short of it. The reductions for this year (1876) are in a forward state.

But probably the work which will be looked on with the greatest interest by astronomers generally is the compilation of a *Third Rawcliffe Catalogue of Stars*, which has been begun during the past year, and in which considerable progress has been made. An index-catalogue has been formed of all the stars, arranged in order of their Right Ascensions, contained in the volumes commencing with 1852 and ending with 1870, which are the limits decided on for the catalogue, and it is found that the total number of distinct stars in this interval is nearly 4,400.

Of these, all the results, both for R.A. and N.P.D., have been written out in sheets prepared and printed for the purpose as far as the end of the tenth hour of Right Ascension, and this work is being rapidly carried forward by Mr. Luff, who has charge of the compilation of the catalogue.

As there is no extra assistance, the completion of the work cannot, of course, be looked for very early ; but it is hoped that the ordinary staff of the Observatory will suffice to prevent any suspension of it for other purposes, and that it will go steadily, if not rapidly, on towards completion.

The reduction of the meteorological observations is, with regard to arrears, in the usual state, and it does not seem possible to advance it much, though no practical inconvenience with respect to the printing is experienced by this circumstance.

Oxford University Observatory.

This Observatory has now been in active operation for little more than a year, and the first report of its proceedings has been published and presented to the Convocation of the University. This latter body has, with great but not unusual generosity, increased the pecuniary grant for the maintenance of the establishment.

Three hundred and fifty photographs of the Moon have been taken with the De La Rue Reflector during the year, and they

are still rapidly accumulating. The time is approaching when these autographic registers are to be utilised for the determination of the nutation, or inequality of the libration, of the Moon's axis. The attention of Professor Pritchard is now directed to the preparation of the details of the necessary mathematical processes; and Mr. De La Rue has undertaken to devise and provide a micrometer suitable for the measurements of these lunar photographs. Concurrently with these preparations the Professor proposes to set on foot a series of measurements with the large Refracting Telescope of five well marked and suitable points on the Moon's disk, so as to provide a check or a verification of the photographic measures. A few photographs have been taken of certain double stars, and of *Venus* and *Jupiter*, at present mainly to gain experience.

The satellites of *Saturn* have been observed during thirty-two nights. The results have been reduced, and, together with a former similar series, will very soon be in a condition for publication.

Two hundred double stars have been measured during the year; these observations also are in a state ready for printing. Considerable time and labour have been bestowed on the calculation of the orbits of certain binary stars, which hold out the expectation of definite results. In common with other astronomers, we have greatly deplored the want of sufficiently numerous and accordant observations. The method adopted in this Observatory for the determination of these orbits is a combination of both the graphical and the computational determination of the elements; and it is believed that considerable advantages have been thereby secured. In the course of these calculations a new and very simple mechanical method of calculating the excentric anomaly has occurred to Professor Pritchard, and thereby much tedious arithmetic has been avoided. It saves all the preliminary trials in the tentative methods for the exact calculation of the excentric anomaly.

The beautiful Sun Spectroscope devised by Mr. Grubb has been nearly ruined by a certain violent maltreatment which it met with in its transit along the railway to Dublin, whither it had been sent for a slight but necessary modification. Its return to Oxford is shortly expected, when restored at the expense of the railway authorities. The large Equatoreal continues to give us entire satisfaction.

Before closing this report it may not be altogether uninteresting to the Society to remind them that, concurrently with the prosecution of original research, one important object which presented itself to the University of Oxford in the institution of this establishment was the resuscitation of the science of astronomy among the students in this ancient seat of learning. The great increase of the numbers who now attend the Professor's lectures in the Observatory affords the prospect of the realisation of this hope. In furtherance of the same object the

Convocation of the University have recently authorised the Vice-Chancellor to seek the advice of Mr. Charles Barry in the erection of a suitable lecture room and library for the use of students. These additions have, in fact, become an absolute necessity for the success of the institution, so far as University studies are concerned.

It has been asked more than once, and by none so anxiously as by the late illustrious Wilhelm Struve, when he was a Professor at Dorpat, whether the co-existence of instruction is detrimental or otherwise to the business and the original work required in an Astronomical Observatory. Professor Pritchard's experience is, that so long as it is kept within its due limits, the devotion of a portion of the Director's attention, during a part of the year, to the instruction of the highest and most intelligent order of students in a great University like that of Oxford is not only of great advantage to the studies of the place, but in many respects it is beneficial to the Professor himself. It provides the astronomer with fresh interests and a pleasant variety of occupation, while it necessitates increased precision and methodical arrangement in his own mind. Further than that, the eager and ingenious curiosity of fresh and cultivated intellects will not seldom set the Professor on the path of new enquiries, or stimulate him to the removal of old obscurities.

Cambridge Observatory.

In a year exceptionally unfavourable for astronomical observations, the places of 3,455 small stars have been obtained, as well as observations of the standard stars required for clock and instrumental corrections.

Since the mounting of the Transit-Circle, the inclination of the axis to the horizon has been gradually increasing, until it amounted to nearly seven seconds, the east end being the higher. Mr. Simms has lately reduced the support of the eastern pivot by scraping, so as to make the axis more nearly level. The west end is now higher by rather more than one second.

In order to improve the illumination of the wires in a dark field, Mr. Simms has given a cylindrical form to one surface of the prisms in the eye-piece. Although some improvement is thus effected, the light is not yet sufficient for satisfactory observation. This is of the less consequence, however, as it is found that by placing a coloured glass before the perforation in the axis, the light in the field can be moderated, so that stars may be observed in the ordinary way to the lowest limit required in the Zone observations.

The discrepancy in the Nadir-point of the Transit-Circle, arising from shake in the telescope tube, had been already

reduced to a very small quantity, not exceeding about one-tenth of its original amount, by means of screws connecting the outer and inner portions of the tube. Mr. Simms has now inserted stronger screws than before, and it is hoped that, in consequence, this discrepancy will entirely disappear.

The alterations kept the Transit-Circle idle during November and December, but this is the less to be regretted, as there was hardly a night on which Zone stars could have been observed.

By means of some additional assistance in computation, supplied by the Sheepshanks Fund, satisfactory progress is being made with the reductions.

All the observations are entered in the reduction books, and the means taken.

The reductions of standard stars, both in Right Ascension and North Polar distance, are completed to the end of 1875, and the Right Ascensions for 1876 are approaching completion.

The apparent North Polar distances of the Zone stars are obtained as far as the end of 1873, and the calculation of the Right Ascension is now in progress.

The Transit Clock was taken to London in March 1876, by Mr. James Brock, of 64 George Street, and underwent a thorough examination and cleaning. Since that time its rate has been much more satisfactory than before.

A new line of railway in connection with the Great Northern system has been lately projected, which is to pass at the distance of about 550 yards from the Observatory, between it and the town of Cambridge. It is hoped that this scheme will not be carried out, as it is Professor Adams's opinion that so great a proximity of the line would be very injurious to the work of the Observatory.

Dunsink Observatory.

During the year the Meridian-Circle has been employed in continuing the observations of the Red Stars contained in Dr. Schjellerup's catalogue. Other stars have been from time to time added to the working list, chiefly taken from the extensive catalogue of Red Stars, prepared by Mr. Birmingham, and now in course of publication. The reductions of these observations are in progress, and have advanced considerably since the date of the last Report. It is intended that each of the stars referred to shall have its co-ordinates determined at least twice in each of the positions of the instrument. Several of the minor planets have been observed as opportunity offered during the year, and their places are now being compared with those of the *Ephemerides of the Berliner Jahrbuch*.

In October 1876, a series of observations of *Polaris* was

commenced for the improvement of the adopted co-latitude, and has been continued to the present date. During each set of observations of *Polaris*, above or below the pole, the Transit-Circle is twice reversed, and the observations are equally divided between the two positions of the instrument. Half the observations are direct, and half by reflexion, distributed as symmetrically as is practicable. It is contemplated to continue this series for some time to come.

The South Equatoreal is being employed in the investigation of the parallaxes of some of the Red Stars above mentioned, together with other stars of physical interest, either on account of variable light, large proper motion, or unusual spectra. A great number of measures have been made, and their reduction is being actively proceeded with.

In addition to the new Sidereal Clock, by E. Dent & Co., mentioned in last year's Report, and used up to the present time, the Observatory now possesses an excellent Mean Time Standard Clock, by Booth, of Dublin, which is employed for the electric control of a clock at the office of the Dublin Port and Docks Board.

A Chronograph, with two barrels, for registration of observations made with the Transit-Circle and South Equatoreal, has been ordered from Mr. Grubb.

The Royal Observatory, Edinburgh.

The Budget granted by H.M. Government for the support of the Royal Observatory, Edinburgh, during the past year, for all salaries and all office expenses therein, has been under £1,100.

The work performed at the same time by the Astronomer and the two assistant astronomers thence maintained, has been :—

1. The service of daily distributing correct time by means of electric time-ball, time-gun, and controlled clocks.
2. The computation of the meteorological observations taken twice a day throughout the year at 55 stations of the Scottish Meteorological Society, for the Registrar-General in Scotland.
3. Calculations for the Edinburgh Star Catalogue; at which the Astronomer reports that the two assistant astronomers, Mr. Alexander Wallace, M.A., and Mr. Thomas Heath, B.A., have greatly distinguished themselves for steady and untiring devotion, both by day and by night, to the multitudinous figure work required.

Among the chief incidents during the period have been :—

1. In January 1876, the temporary contribution by the Astronomer of several pieces of apparatus to the Loan Collection of Scientific Instruments at South Kensington, London.
2. In February, the appointment by H. M. Office of Works in

London, of Mr. Christie, of Greenwich, to examine the Edinburgh Equatoreal, not yet out of their contract with the maker, and to report to them upon it.

3. In June, the construction in France, at the Astronomer's private expense, of a large spectroscopic instrument, such as the Royal Observatory, Edinburgh, has long been in urgent need of, but was never able to obtain the necessary funds for, from any other quarter.

4. In July, the arrival of a Government Commission of Enquiry, under the presidency of Lord Lindsay, to report upon everything relating to the Observatory.

5. In September, the breakage, by a mad sailor from Leith, of the whole of the Observatory's deep-soil thermometers, whose regular observation, during 39 years past, has formed a distinct and not unimportant branch of the work of the Observatory. The man who committed the mischief is now in a lunatic asylum maintained at the public expense; but the Observatory has no funds wherewith to repair its dismal loss.

6. In December 1876, the furnishing by the Astronomer, at command of H.M. Principal Secretary of State for Home Affairs, the Right Hon. R. Assheton Cross, M.P., suggestions as to renewing the deep-soil thermometers; these being viewed as instruments successfully proved by previous experience here, and more recently at the Royal Observatory, Greenwich, to have a direct bearing on certain grand cycles of other than annual heat-waves affecting the Earth from without.

Glasgow Observatory.

The operations at the Glasgow Observatory during the past year have mainly consisted in reducing to the mean equinox of 1870, and preparing for the press, the meridional observations of stars, which have been accumulating at the Observatory since the year 1860. The task is a very laborious one, as is well known to those who have had experience of such observations; but in an Observatory like that of Glasgow, where the provision for assistance is on a very limited scale, it is especially so. Professor Grant has recently called the attention of the Town Council of Glasgow and the Clyde Trustees to the desirability of their co-operating with the Observatory more effectually than heretofore in supplying the City and Port of Glasgow with the advantages of correct time. The Town Council have cordially taken up the subject, and it is probable that ere long a considerable extension will be given to the system of controlling clocks by electricity, which has been in successful operation here during the last thirteen years.

Kew Observatory.

The photoheliograph not being in use at Kew has been deposited for the past year in the Loan Collection at South Kensington, where it has been exhibited, together with a number of Solar negatives.

The re-examination of the measurements of the Kew Sun pictures, taken during the ten years 1862-1871, has been steadily carried on under Mr. De La Rue's direction, and has now advanced as far as the middle of 1870. Progress is somewhat slow at present, owing to the enormous number of spots which the pictures contain at this epoch, many of them having over forty, of which accurate determinations of position are made. A correction for the optical distortion of every picture is now being applied to the measurements.

The ephemerides for the whole period of the Kew Sun-spot observations have been re-calculated by Mr. Marth, and are now in the Observatory. Mr. Marth is now engaged on the reduction of the measurements of the Solar photographs.

At the request of Mr. Hind to Mr. De La Rue, a careful inspection has been made of the Kew Sun pictures from 1858 to 1875, with a view to obtain evidence as to the existence of the intra-Mercurial planet. The observations bearing on the question have been communicated to that gentleman. The whole of the expense attendant on the Sun work has been borne by Mr. De La Rue.

Mr. C. S. Peirce, of the United States Coast Survey, who has recently been making pendulum observations at Berlin, Geneva, and Paris, arrived at the Observatory in June; after having had the necessary fittings put up in the pendulum-room, he erected his apparatus, and made a complete series of vibrations. He has since returned to America.

The magnetical and meteorological work, to which the attention of the Observatory is chiefly directed, has been prosecuted continuously, and a large number of instruments have undergone verification in the department devoted to that duty.

Liverpool Observatory, Bidston, Birkenhead.

No important change has been made in the working of this Observatory during the past year.

About 300 new chronometers are tested annually in the three definite temperatures of 55°, 70°, and 85° of Fahrenheit.

Makers are much more successful than formerly in so adjusting the weights on the balance, that the maximum gaining rate shall be at about 70° of Fahrenheit.

The average loss at 15° from the temperature of maximum gaining rate is still found to be between six and seven tenths of a second, and at 30° between two and three seconds a day.

About twenty years ago, a few chronometers were tested at the old Liverpool Observatory, the balance rims of which were cut through at 90° from each end of the balance arm, and four small weights were used. By means of three holes, for small screws, between each weight and the balance arm, the final adjustments for compensation were greatly facilitated. The loss at 30° from the temperature of maximum gaining rate, in chronometers with balances so made, did not appear to be more than the loss at 15° with balances made in the ordinary way. This subject is well worthy the attention of chronometer makers.

Temple Observatory, Rugby.

The measurement of the positions and distances of double stars has, as in previous years, been the chief work of this Observatory. Owing principally to the unusually bad weather, the number of stars measured, 183, is somewhat small. The selection includes many stars of which the binary character is more or less doubtful, the examination of which has been undertaken in preparation for the list of double stars recently presented to the Society by Mr. Wilson and Mr. Gledhill.

The spectroscopic observations of the Sun have been discontinued, as they are now regularly made at places which enjoy a better climate. The earlier observations have been published by the Royal Society in conjunction with Mr. Lockyer's; and those of later years will be published by the Rugby Natural History Society.

The Spectroscope on the 12-inch reflector has been arranged by Mr. Seabroke, for the examination of the spectra of stars, with the view to obtain confirmatory measures of the rates of their approach or recession, and some progress has been made in this direction.

As in previous years, considerable attention has been paid to the educational use of the Observatory, which receives many visits from members of the school.

The existing wooden Observatory being in a bad state of repair, it has been decided to build a new and permanent one, with a curator's cottage adjoining, and the Governing Body have purchased a suitable site. They are, however, unable to contribute towards the expense of building; and a fund is being accumulated for this purpose. Mr. E. Crossley has presented a transit instrument, and Mr. Wilson would most thankfully receive any gifts, whether of money, instruments, books, or

photographs, which will advance the objects of the Observatory. The subscriptions at present amount to about £425, and the total sum required will not be less than £1,000.

Stonyhurst Observatory.

The astronomical work at this Observatory during the past year has been somewhat interfered with by the sickness of the first assistant, and by the change of the computer in the meteorological department. The uninterrupted series of meteorological and magnetic observations, and their reduction, demanded most of our time, but the phenomena of *Jupiter's* satellites, and the usual watch for meteors, were not neglected. A number of experiments were made with the spectroscope for determining the easiest method for simultaneous observation of the chromosphere and solar limb, with the view of preparing for the Transit of *Venus* in 1882, or any similar phenomenon. Previous to this year the Observatory was not provided with a chronograph, but one has lately been procured from Paris, to be used principally for small differences of R.A., in mapping small portions of the heavens, and in observations of *Mars* this year. More time than usual has been devoted lately to the instruction of students in methods of observation.

Mr. Barclay's Observatory, Leyton, Essex.

The work of the past year has mainly been the observations of double stars. Eclipses, occultations, and phenomena of *Jupiter's* satellites have also been observed when possible. It is proposed to publish a fourth volume of Observations at the close of the present year.

For the last two years the weather here has not been very favourable for astronomical work.

Mr. Bishop's Observatory, Twickenham.

Mr. Bishop's Observatory was closed at the end of last year. Purposing to reside for the greater part of the year in the South of Europe, it has been his intention for some time past to relinquish astronomical observations at Twickenham, and during the last fifteen months the Observatory has only been retained in operation with the view to endeavour to complete several of the charts of small stars lying near the ecliptic, chiefly where it

is crossed by the *Via Lactea*, and consequently where the formation of such charts, from the great number of the stars, is necessarily very slow and tedious. The weather of the past twelve months has been generally unfavourable for such work in this locality, but two additional charts have been completed. Variable stars, principally those detected at Twickenham, have been watched on nights when the small star-work could not be advantageously proceeded with, and a list of these stars, with particulars showing the grounds upon which their variability has been inferred, is ready for the press, and will shortly be distributed, together with the original observations of comets, *i.e.* differences of R.A. and declination with comparison stars, taken at the Observatory.

Mr. Bishop has presented his 7-inch equatorially-mounted refractor, and other instruments, with his astronomical library, to the Royal Observatory at Naples, to which they are now in course of removal.

Colonel Cooper's Observatory, Markree.

Micrometrical measures of double stars have been continued by Dr. Doberck during the past year. The usual meteorological observations in the manner described in the previous Report have also been made. The exposure of the refractor in the open air for so many years, without proper protection from wind and rain, has seriously affected the instrument, which Dr. Doberck fears can never be remedied.

Mr. Edward Crossley's Observatory, Bermerside, Halifax.

As in previous years, the observer's attention has been directed almost exclusively to the measurement of double stars. The well-known binaries have been measured as often as the exceedingly bad observing weather permitted, and a large number of Σ 's stars have been examined with a view to the formation of a complete list of those deserving of careful attention for some years to come.

The weather of 1876 was very bad. The number of nights in which some work could be done was 75; of these 40 were bad and 34 fair: one only was fine enough throughout for the measurement of the most difficult objects.

Very complete lists of measures of all the most interesting double stars have been collected, and much historical matter gleaned from the scientific journals, transactions, &c., which are to be found in the Society's library.

Mr. Huggins' Observatory.

During the last two years arrangements have been in progress for the application of photography to the spectra of the stars. For this purpose a Reflector with a speculum of 18 inches diameter has been mounted in the place of the 15-inch Refractor. The motion of the driving clock was then found to be not sufficiently uniform for these observations. Mr. Grubb, by means of an original contrivance, has successfully applied to the clock the control of a seconds pendulum in electric connection with a sidereal clock. This system works quite satisfactorily.

The spectroscopic part of the apparatus is constructed with a prism of Iceland spar and lenses of quartz. This apparatus is so arranged that a solar or electric spectrum can be taken on the same plate, for comparison with the spectrum of the star.

After an extensive trial of different photographic processes, preference has been given to dry plates. Among other advantages, a dry plate can be left in the apparatus until the following day, when a solar spectrum can be taken upon it through the half of the slit which was closed when the instrument was directed to the star.

In the early part of 1863 photographs of the spectrum of *Sirius* were taken in this Observatory, but from several causes no distinct indications of lines were obtained. Other investigations prevented these experiments from being pursued further at that time, but the intention of continuing them was never abandoned.

During the past year spectra with distinct lines of *Sirius*, *Vega*, *Venus*, and the Moon, have been obtained in juxtaposition with well-defined and detailed solar spectra. The continuously unfavourable weather for the last few months has prevented as yet the extension of this investigation to the spectra of other stars.

Lord Lindsay's Observatory, Dun Echt, Aberdeen.

The past year has been chiefly devoted to the continuation of the reduction of observations immediately connected with the Transit of *Venus*. At the same time, many of the instruments used at Mauritius have been remounted and tested.

The 15-inch Grubb refractor has been revised in several of its details, and a few observations have been taken with it. In particular may be mentioned determinations of the wave-lengths of the bright lines in the spectrum of Dr. Schmidt's *Novæ*.

The Earl of Rosse's Observatory, Birr Castle, Parsonstown.

The past year has been about an average one for astronomical work at Parsonstown.

On 41 nights 161 sets for nebulæ have been made with the 6-foot reflector, and eight observations with the 3-foot are recorded.

The satellites of *Saturn* were observed on four and that of *Neptune* on two nights.

The work with the 6-foot consists chiefly of micro-metrical measures, and has been directed as far as possible to points on which, in preparing past observations for publication, further examination seemed most required.

The 3-foot is now re-mounted as an equatoreal in, it is believed, a very satisfactory manner. It remains of the Newtonian form, but it is intended to arrange for its occasional employment in the Herschelian, or front view form, and this has been all along kept in view. The instrument has been found extremely steady, and Lord Rosse's assistant, who has observed with it on windy nights, has never complained of the least vibration. The clock appears to carry it with sufficient regularity for ordinary work in Right Ascension without the assistance of the controlling pendulum, which was ready for application. The gallery and telescope can be moved with ease, and the motions of both within a considerable range are within the control of the observer. When arrangements have been made for enabling him to read the setting circles from the eye-piece, and a collimator for correcting the axis of collimation has been fitted, Lord Rosse believes that he shall possess an instrument from which, owing to its universality of range and its general handiness, much useful work may be expected, notwithstanding its inferiority to the 6-foot in "space penetrating power."

It is intended after a few small additions (including those mentioned above) have been satisfactorily carried out, to describe fully the mounting, which differs in several particulars from any hitherto constructed, and of which a model, showing the general arrangement, has been deposited in the Loan Exhibition of Scientific Instruments.

The meteorological observations continue to be made without alteration, and a monthly return is sent to the Meteorological Office. The return of rainfall for the year only is sent to Mr. Symons, and the Observatory has been just selected as one of four which are to send weekly returns of temperature to the Registrar-General for Ireland.

Colonel Tomline's Observatory, Orwell Park, Ipswich.

Observations were made at this Observatory during the spring of last year for the comparison of the light of *Venus* with that of

the full Moon, and after several attempts a most successful result has been obtained, which has already been communicated to the Society. The equatoreal has been employed to make a series of comparisons of *Venus* with λ *Geminorum* near the time of their conjunction on August 17 last, and, although only with partial success, some facts were elicited that have been thought of sufficient interest to merit the notice of astronomers.

With the meridian instrument it has been found possible to complete the determination of the longitude of the Observatory from transits of the Moon and culminators.

A comparison of the Right Ascensions of the catalogues of Greenwich (1864) and Armagh, has shown that, of 2,028 stars whose proper motions have been investigated, 196, or nearly 10 per cent., differ by a larger amount from the present adopted proper motions than can be supposed to be due to errors in the catalogue places themselves. Each of these stars has therefore been observed upon the meridian on three separate occasions, in order to obtain the latest possible data for the further prosecution of the enquiry. The reduction of these observations, together with those for the determination of the longitude, are now being proceeded with.

Owing to the non-discovery of comets during the last two years, the main feature in the plan of operations proposed for the work of this Observatory cannot as yet be carried out. Among the questions that may enter into the plans for the ensuing year it is hoped that stellar photometry may take a prominent place.

Royal Observatory, Cape of Good Hope.

The volume containing the Meridian Observations made during the years 1871, 1872, and 1873 has been distributed for the use of astronomers. It contains positions of all the stars in Lacaille's zones, and some other stars of about the seventh magnitude, within fifteen degrees of the South Pole.

A printed copy of the volume of Results, 1874, but without the Introduction, which is not yet passed through the press, is forwarded with the present report.

The Catalogue for 1874 contains the mean places of 1,246 stars; nearly all observed three times. The stars consist chiefly of Lacaille-stars, in the zone 165° to 155° N.P.D. The discordance between the Nadir points which existed in 1871 to 1873 has sensibly disappeared, since the readjustment of the Transit-Circle by Mr. Stone. The corrected results of 1871-1873 agree, however, very closely with the corresponding observations made in 1874.

A Catalogue has been formed from the observations made here from 1834 to 1840, both inclusive. Some considerable

progress has been made in the printing, but this has been stopped for some time, to allow of the results for 1874 being passed through the press.

The observations made during the year 1875 are reduced to mean places. The Catalogue will contain positions of more than 2,000 stars, chiefly from Lacaille's zones, 155° to 145° N.P.D. Each star has been usually observed three times.

The observations made in 1876 have consisted chiefly of Lacaille stars in the zone 145° to 135° N.P.D., but many stars of the seventh magnitude, not in Lacaille, have also been observed. The total number of stars observed is about 2,200, and, with the exception of 10 or 12 which have only been observed twice, each star has been observed three times.

The working Catalogue for 1877 contains Lacaille stars in the zone 135° to 125° N.P.D., Brisbane's stars of not less than the seventh magnitude which have not yet been observed, and a few stars of the eastern zones which it has appeared desirable to re-observe.

Arrangements have been made for the formation of a general catalogue, which is intended to include all the observations made here from 1871 to 1878. Some considerable progress has been made in the systematic preparation of the materials already collected, but much more might be done in that direction if our computing staff were slightly increased.

The Photoheliograph was mounted and brought regularly into use in February 1876. Photographs were obtained on every clear day during the months of February, March, and April, but the weather then broke up, and it has been found impossible to carry on the work with regularity without an increase of the staff, or without seriously interrupting the works in progress. This has not been considered desirable. The photographs were all taken by Mr. Stone without assistance. A considerable number of absolute determinations of the magnetic elements have been taken by Mr. Stone during the year 1876.

The Meteorological observations have been taken with regularity, and reduced.

A distribution of time over a considerable portion of the Colony has been carried out with accuracy and a regularity only limited by occasional breaks in the telegraphic communications.

The work of the year has to some extent been interrupted by the resignation of one of the assistants, and a long delay in filling up the appointment.

Melbourne Observatory.

It appears from Mr. Ellery's last Report to the Board of Visitors of the Melbourne Observatory that the general work of the preceding year has been carried on in the same manner as before, the observations with the Transit-Circle being limited as

much as possible, so as to allow more time for the compilation of the annual catalogues, which were in considerable arrear. The subjects of observation during the year were the usual standard stars for clock-error, the stars used for the determination of azimuthal error, and a series of special stars observed by the American Transit of *Venus* party in New Zealand for finding the latitude of their station. The number of stars observed in Right Ascension was 1,211, and in polar distance 454.

The great telescope has been employed regularly for the examination of the nebulae and clusters previously delineated by Sir John Herschel. Seventy of these have been examined, measured, and sketched; most of them are carefully drawn and described, and are ready for publication. Mr. Ellery remarks that the drawings and measurements indicate that several of the nebulae are considerably changed, while others appear so completely altered as to be scarcely recognisable, except by their relative position to the neighbouring stars. All these changes have been carefully noted. During the year there were 150 nights more or less fit for observing with the great telescope, but of these forty were solely occupied with visitors, and quite lost for astronomical work. Perhaps, as an act of policy, this great interference in the observing duties of the staff may be necessary in a Colonial Observatory, but it seems rather too great a sacrifice to give up more than a quarter of the stated work of the observers to satisfy the curiosity of unprofessional star-gazers.

Several drawings of *Mars* and *Jupiter* have been made—of the former in June 1875, and of the latter in May 1876. Observations also of the conjunction of *Saturn's* satellites were made in 1875, from August 26 to December 29, with the view of more accurately determining their periods. Ten only out of ninety conjunctions could be observed, owing to so much cloudy weather. These observations were intended to be continued in the autumn of 1876.

The photoheliograph has been employed, and a Sun picture has been obtained on almost every day that the sky was sufficiently clear. During the year 143 heliograms have been secured.

In the regular work of the Observatory for the ensuing year Mr. Ellery intends to continue the observations with the Transit-Circle, as the fundamental work of the establishment. The revision of Sir John Herschel's figured nebulae is to be continued with the great telescope, and the same instrument will also be employed upon occasional planetary observations. In connection with this telescope, Mr. Ellery remarks:—"I may mention that, although the mirrors retain their high reflecting polish exceedingly well, the fact must not be overlooked that the time when they will have to be repolished will inevitably arrive, and that perhaps earlier than we now anticipate. I intend, therefore, to devote some time this year to practice in grinding and polishing large surfaces, in order that both Mr. Turner and myself may obtain further experience in the matter. I also hope to personally undertake a series of observations with the south equatoreal (8-inch), more

especially of the objects to be observed with the great telescope, for the purpose of micrometric measurements, which will, I anticipate, enable the larger instrument to be devoted more exclusively to the figuring and revision of the features of the nebulæ."

During his recent visit to Europe, Mr. Ellery made enquiries concerning the best means of reproducing for publication the valuable collection of drawings of nebulæ now in hand; but though he inspected many proposed methods, the result was not satisfactory. He has since seen, however, some specimens of a toned lithograph, white on black ground, the work of an officer attached to the Mining Department, on which the nebulæ are represented as they appear in the telescope more nearly than by any other method which he has examined. There is, therefore, some hope that the results of the observations of the Great Melbourne Telescope will, at no distant date, be in the hands of astronomers, as there is already a considerable amount of work of great interest ready for publication as soon as the method to be employed in the reproduction of the nebulæ is decided on.

NOTES ON SOME POINTS CONNECTED WITH THE PROGRESS OF
ASTRONOMY DURING THE PAST YEAR.*The Numerical Lunar Theory.*

The Numerical Lunar Theory, on the state of which the Astronomer-Royal has occasionally given some Reports to the Society, has advanced steadily, interrupted only by some errors in operations incurred by an assistant's trusting too much to his own judgment and accuracy. With the view of placing the work which is done in a position of safety against ordinary contingencies, a considerable portion has been already printed, in readiness for ultimate distribution, both as an Appendix to the *Greenwich Observations* and as an independent treatise. The following is the general state of calculations and of printing:—

The general form of the theory is drawn up, nearly in the same shape in which it was first exhibited to the Society (omitting for the present the terms depending on the Earth's oblateness and the change of the plane of the ecliptic), and is printed.

The first step in the application of the theory is, to develop for the left side of each of the three theoretical equations (that is, the side which depends entirely on the actual place of the Moon, but without explicit reference to perturbing forces) all the successive steps leading up to that left side as derived from Delaunay's numerical values of the three co-ordinates; which values are supposed to be not true, but so near to the truth that the squares of the corrections which they require may be neglected. This development is exhibited in numerical tables of great extent. There are 39 columns, each exhibiting a separate development as one of the steps towards the completed development of the left sides; the terms of each column consist of multiples of sines or cosines with different factors and different arguments; and the number of these terms in each column varies from 100 to 287, all carried to the 7th decimal. The whole of these results are printed.

The next step is—supposing each of Delaunay's terms to require a correction, which, before its magnitude is ascertained, must be used in the shape of a Symbolical Variation (S.V.)—to find the factors of these S.V. of Delaunay's terms, by application of which the S.V. of the terms of the left side of the equations will be formed. The theory of this transformation is printed; all preparations for the transformation are prepared, and nearly all the work is done.

It has been found desirable to abandon the use of the "Equation of Virtual Velocities," adopted in the first sketch of

the theory, and to substitute for it the "Equation of Radial Forces." The addition which this change introduces into the calculations is small.

It will be seen, therefore, that the left sides of the equations are very nearly completed. The Astronomer-Royal contemplates the possible extension of some terms on which the more accurate movements of the apse and node depend; and, indeed, the work has been begun; but it is not absolutely necessary for the principle of the general theory, and the extension is for the present suspended.

Of the right side of the equations, which contains the computed perturbing forces, a large portion has been some time since completed, and the Astronomer-Royal contemplates a very early devotion of the powers of the establishment to the computation of the whole perturbation-side, and to the exhibition of the detailed equations which contain the solution of the whole problem.

*Reduction of the Observations of the Transit of Venus,
December 8, 1874.*

In the Annual Report of the Council last year, page 177, the state of the Reductions was described in considerable detail. They have been continued throughout the year under Captain Tupman, assisted by Lieutenant Neate, R.N., until November, and generally four computers. The great mass of the work, prepared on skeleton forms, has been done outside the Royal Observatory. Referring to the headings of the last Report:—

(1.) All observations with transit instruments, for local time and longitude, are completely reduced.

The longitudes of Honolulu and Rodrigues by the observations of the Moon in zenith distance, are completely reduced. These two calculations required the use of three millions of figures. The zenith point of the vertical circle employed at Rodrigues was subject to variations not yet explained, and it is possible the longitude may require a slight correction.

For Kerguelen's Island, chief station, the transit work, comparisons of clocks, latitude, and instrumental constants of the Altazimuth are reduced. The observed azimuths of the Moon, about 130 in number, and each compared with a star, and the interpolations of the Lunar elements, are in hand.

An element of great importance in the reduction of these longitudes is the amount of the correction to be applied to the Moon's Tabular Place. This is the subject of a separate communication to the Society by Captain Tupman, which will be printed in a future number of the *Monthly Notices*.

(2.) The differences of longitude between the various stations

in the Hawaiian Islands and between Honolulu and San Francisco are nearly concluded.

(3.) The *Greenwich Sidereal Times* of every photograph, micrometric measure, and other observation, in Egypt, Honolulu and Rodrigues, and of every photograph at Roorkee (Colonel Tennant's station) during the actual Transit, have been adopted, employing provisional longitudes for Honolulu and Rodrigues founded on the meridional observations of the Moon.

(4.) The whole of the calculations necessary to compare the proportions of Mr. De La Rue's material scale with its image as photographed 24 times by each of the five photoheliographs have been performed in duplicate, and the means of the results have been taken for each picture. For two of the instruments, the computation of the distortion has advanced another stage—that of arranging it in angular directions around the centre of the field. In this work, 2,800 pages of ordinary foolscap size were closely covered with figures. There remains to deduce the curve of distortion in the different azimuths, and to convert the results into a form convenient for application to the measures of the Solar photographs.

(5.) Mr. C. E. Burton continued the measurement of the photographs until the end of April 1876, when, unable any longer to support the great strain upon his eyesight, he was compelled to abandon the work. During the seven months he was engaged upon it he made upwards of 38,000 bisections with the microscopes.*

The following is a list of the photographs of the actual transit measured by him :—

Thebes (Egypt).—*Ingress.*

34 square plates with *Venus* entirely within the Sun.

28 small pictures † on a circular plate with *Venus* at internal contact.

55 small pictures on two circular plates, the planet being bisected on the Sun's limb.

Honolulu.—*Ingress.*

12 square plates with *Venus* approximately bisected on the Sun's limb.

38 square plates with *Venus* entirely within the Sun.

Rodrigues.—*Entire Transit.*

24 small pictures (*Ingress*) immediately after external contact.

23 small pictures (*Ingress*) about the time of bisection.

* We are happy to state that Mr. Burton, who is now First-Assistant at Dunsink Observatory, has entirely recovered.

† By *small pictures* are meant those containing only that portion of the Sun's limb contiguous to the planet. On *square* plates the Sun is always entire. All the measurements are along the line of centres.

37 small pictures (*Ingress*) about the time of internal contact, *Venus* entire.

35 small pictures (*Ingress*) just after internal contact, *Venus* entire.

52 square plates during transit.

27 small pictures at *Egress* just before internal contact, *Venus* entire.

Burnham, New Zealand.

13 square plates at *Mid Transit*.

Kerguelen's Island.

Attempts were made to measure 8 square plates (at *Mid Transit*), but the photoheliograph appears to have been hopelessly out of focus on the day of the transit.

Roorkee.—*Entire Transit*.

53 small pictures at *Ingress*. *Venus* approximately bisected.

84 square plates during transit.

7 square plates at *Egress*. *Venus* approximately bisected.

Melbourne.—*Entire Transit*.

3 square plates at *Ingress*. *Venus* approximately bisected.

26 square plates during transit.

Sydney, N.S.W.—*Entire Transit*.

20 square plates during transit. *Venus* entire.

Eden, N.S.W.—*Entire Transit*.

16 square plates. *Venus* entire.

Woodford, N.S.W.—*Entire Transit*.

20 square plates. *Venus* entire.

Some 300 small pictures taken at Roorkee, Melbourne, and Sydney have not yet been measured; nor have any measurements yet been made for the distortion of the instruments used at these stations, Eden and Woodford.

(6.) The Tabular *local* distances of the centres of the Sun and *Venus* as affected by parallax, and the factors of corrections to distance for time and parallax, have been computed for every photograph, micrometric measure, and other observation of the actual transit in Egypt, Honolulu, Rodrigues, and for every photograph at Roorkee.

The work remaining may be briefly stated as follows:—

The completion of the longitudes of Kerguelen and Burnham, N.Z., by the Lunar observations, and of Honolulu and dependencies from San Francisco by chronometers, and of the distortion of the five photoheliographs; the determination of the distortion of the Indian and Colonial photoheliographs, including the measurement of the necessary photographs; the measurement of the remaining Sun pictures; the calculation of the local elements for Waimca and Kailua (Hawaiian Islands), Burnham, N.Z.,

Kerguelen (3 stations), Melbourne, Sydney, Eden, and Woodford; and, lastly, the treatment of the results.

It is impossible to form an even moderately accurate estimate of the time which will be required to finish all this work. It was hoped that more would have been done during the past year, but unexpected delays occurred, one of which was a serious illness of Captain Tupman, which totally incapacitated him for work for three months; other delays are caused by the necessity which often arises of going again over work believed to be free from error.

It is not proposed to commence the printing until the calculations are further advanced.

M. Le Verrier's Planetary Researches.

In the address of Professor Adams delivered at the last Anniversary Meeting of the Society, a complete abstract is given of M. Le Verrier's planetary investigations as far as chapter xxiii., and now the Council have much pleasure in recording that at the *séance* of the Academy of Sciences held on November 20, 1876, chapters xxiv. to xxvii. of his *Recherches Astronomiques* were communicated by him, containing the detailed explanations of the theories of *Uranus* and *Neptune*, which thus complete his laborious researches on the theories of the eight principal planets. Tables of *Uranus* were presented in manuscript to the Academy at the same time. In this immense work M. Le Verrier has been able to follow the same system throughout his investigations, owing principally to the long-continued series of planetary observations made at the Royal Observatory at Greenwich from 1750 to the present day, which have been reduced with great order and precision, and made available for his purpose in such a form as cannot be found elsewhere. M. Le Verrier remarks that since the discovery of *Uranus* in 1781, a very large number of accurate observations have been made; and on account of its small magnitude the planet has been observed with the same accuracy as a star. For this reason, the observations made during the ninety-two years from 1781 to 1873 have been exclusively employed in the present investigation. In the comparison of the theory with the observations, the latter are represented with the precision that might have been expected from their small probable error.

The Tables of *Uranus* and *Neptune*, forming chapters xxviii. and xxix. of the *Recherches Astronomiques*, are both ready for the press, and the printing, it is expected, will proceed without interruption. The Council cannot refrain from offering to their distinguished Associate their sincere congratulations on the near and successful termination of his great undertaking.

The Nautical Almanac for 1880.

In the *Nautical Almanac* for 1880, an important addition has been made to the list of standard stars, ordinarily used for the determination of instrumental and clock-errors, the apparent places of which are given for every ten days throughout the year. In observatories where observations are made at all hours of the day and night, it is highly desirable that there should be a quick succession of clock-stars, not only for the convenience of the observer in his ordinary work, but also in continuous unfavourable weather when the available time of observation is frequently confined to the few minutes interval during temporary breaks in the clouds. This extended list will, therefore, be found very useful in observatories where the observations of stars are confined mostly to those for which apparent places are given in the *Nautical Almanac*. The new stars have been selected principally from the Greenwich clock-star list, which is annually prepared for use at the Royal Observatory, and freely circulated among the principal home, foreign, and colonial observatories. These additional apparent places of the stars given in the *Nautical Almanac* for 1880 will also be a great boon to the computer, who will in consequence be relieved of a considerable amount of daily calculation. Possibly at some future time space will be found in the Almanac to include most of the stars in the Greenwich list; meanwhile, astronomers are much indebted to the Superintendent for his very valuable and voluntary addition to our national ephemeris. As the standard stars have been well observed at Greenwich during the nine years from 1868 to 1876, it is hoped that the adopted mean places will be taken, as soon as possible, from the *Nine-year Catalogue* now in course of active preparation.

Another important feature in the *Nautical Almanac* for 1880 is the substitution of Le Verrier's Tables of *Saturn* for those of Bouvard, which have been in use since 1834. The new Tables have been communicated by M. Le Verrier to the Superintendent, in anticipation of their publication. The tabular places of *Saturn*, as well as those of the Sun, *Mercury*, *Venus*, *Mars*, and *Jupiter*, are, therefore, now derived from Tables constructed by that astronomer.

Solar Physics.

The quiescent state of the Sun during the past year has not been favourable to physical investigations, but, notwithstanding this, some interesting results have been obtained in this branch of astronomy. The Italian Spectroscopic Society* continues its

* *Memorie della Società degli Spettroscopisti Italiani.*

work on the Solar prominences, and one of its most distinguished members, Professor Tacchini, has taken advantage of the lull in the activity of the Sun to discuss his observations of 1871 and 1873. A comparison of these two series shows that in 1873 the number of prominences had decreased to one-half of what it was in 1871, and that in both years twice as many were observed on the west limb as on the east. Further, there was in 1871 a preponderance in the northern hemisphere, whilst in 1873 the prominences were pretty equally divided between the northern and southern, with a rapid diminution in number, for both years, from the equator towards either pole. In the present year Professor Tacchini finds that the height of the chromosphere has not diminished much, and that the circulation of magnesium is as active as ever, though hydrogen prominences and metallic eruptions are now very rare. He further connects the absence of sodium in the chromosphere with the present paucity of Sun-spots, and considers it likely that this element may have a large share in their formation. The granules and faculæ appear now to be very marked, notwithstanding the absence of spots.

In partial opposition to this are Mr. Trouvelot's observations* on what he has called "veiled spots," from which he concludes—

"1. That during this year and especially during the interval from June 10 to August 18, and to a less degree to September 14, the chromosphere has been notably thinner than usual upon the entire surface of the Sun.

"2. That the granulations have been smaller and less numerous.

"3. That the light-grey coloured background seen between the granules has been more conspicuous and has occupied more space than usual.

"4. That there are spots which he has named 'veiled spots,' which are seen through the chromosphere which is spread over them like a veil.

"5. That these veiled spots are true openings of the photosphere, like those of the ordinary spots.

"6. That during this period these spots have been larger, darker, and more numerous than he has ever before seen them.

"7. That the veiled spots are scattered throughout all latitudes, though more complicated in the regions where the ordinary spots make their appearance.

"8. That he has observed spots at least within 10° of the north pole of the Sun.

"9. That the flocculent objects sometimes seen projected on the umbra and penumbra of spots are the remaining portion of the granulations composing the chromosphere, more or less dissolved by the forces emanating from the interior of the photosphere."

Professor Langley has continued his discussion of the question of the relative amount of radiation from the Solar photosphere,

* *American Journal of Science and Arts*, No. 63, xi., March 1876.

and from the umbra and penumbra of a spot respectively, and its bearing on the *direct* effect of Sun-spots on terrestrial climates. An interesting paper by him on the subject will be found in the *Monthly Notices* for last November, and it will therefore be sufficient to mention, in this connection, that his observations show the umbral radiation to be 54 per cent. and the penumbral 81 per cent. of the radiation from the same area of photosphere; from which he concludes that the greatest admissible *direct* effect of Sun-spots is to diminish the Solar radiation by a quantity somewhat less than 1-1000th and somewhat greater than 1-1100th part, giving for the limits of possible *direct* effect on terrestrial climate three-tenths and one-twentieth of one degree centigrade.

A discussion has been made by M. Tisserand* of the observations of the Sun, taken by Carrington's method at the Toulouse Observatory in 1874 and 1875, the result being to show that either Carrington's or Spoerer's formula will satisfy the observations sufficiently well, though the motions of some of the individual spots are very erratic. M. Tisserand mentions particularly one which had such a rapidly increasing proper motion that after six days its daily motion was found to have decreased by one-tenth of its amount. Professor C. A. Young† has attacked the same question of the Sun's rotation, with the spectroscope, though rather with the object of verifying the principle of the displacement of lines in the spectrum, from the motions of the source of light, than with the idea of obtaining an accurate value of the period of rotation. From the relative displacement of the D and other lines at the east and west limbs respectively, he finds the equatoreal velocity to be 1'42 miles per second, while direct observation of Sun-spots gives 1'25. He is inclined to think that this discordance indicates a physical fact, and that the solar atmosphere really sweeps forward over the underlying surface in the same way that the equatoreal regions outstrip the other parts of the Sun's surface. This conclusion is opposed to the results of the Greenwich observations, which are in remarkably close agreement with the received value of the Sun's rotation.

Professor Young's observations were made with a fine diffraction grating by Mr. Rutherford, in which the spectra of the sixth and eighth orders were observed, the difficulty caused by overlapping in the spectra of the higher orders being obviated by the device of placing a prism in front of the object-glass of the viewing telescope, with its refracting edge perpendicular to the lines in the grating. The red of one spectrum is thus seen below the yellow of the next, which in turn is below the green of the succeeding spectrum, and so on. With this diffraction spectroscopie Professor Young‡ has detected the duplicity of the 1474 line in the Solar spectrum, the two components being

* *Comptes Rendus*, No. 14, lxxxii., April 3, 1876.

† *American Journal of Science and Arts*, No. 71, xii., November 1876.

‡ *American Journal of Science and Arts*, No. 66, xi., June 1876.

unequal. The coronal line corresponds to the stronger of the two, whilst the other is one of the faint lines in the spectrum of iron.

Discovery of Minor Planets.

Thirteen minor planets have been discovered since the last Annual Meeting. Though considerably less than in the preceding twelve months, yet the number is far above the general average of yearly additions to the group. The names of the planets and their discoverers, and the dates and places of their discovery, are given in the following table:—

No.	Name of Planet.	Discoverer.	Date of Discovery.	Place of Discovery.
(160)	Una	C. H. F. Peters	1876 February 21	Clinton, U.S.
(161)	Athor	J. Watson	April 18	Ann Arbor, U.S.
(162)	Laurentia	Prosper Henry	April 21	Paris.
(163)	Erigone	Perrotin	April 26	Toulouse.
(164)	Eva	Paul Henry	July 12	Paris.
(165)	Loreley	C. H. F. Peters	August 10	Clinton, U.S.
(166)	Rhodope	C. H. F. Peters	August 17	Clinton, U.S.
(167)	Urda	C. H. F. Peters	August 29	Clinton, U.S.
(168)	Sibylla	J. Watson	September 28	Ann Arbor, U.S.
(169)	Zelia	Prosper Henry	September 28	Paris.
(170)		Perrotin	1877 January 10	Toulouse.
(171)		Borrelly	January 13	Marseilles.
(172)		Borrelly	February 5	Marseilles.

The following six minor planets, the discoveries of which were recorded in the two preceding Reports, have been named during the past year:—

No. (139)	Juewa.	No. (150)	Nuwa.
„ (148)	Gallia.	„ (154)	Bertha.
„ (149)	Medusa.	„ (155)	Scylla.

It is at length found impossible to continue the computation of the opposition ephemerides usually inserted in the *Berliner Jahrbuch* for all the small planets which come into opposition during the year. Space has only been found for fifty out of 125, which will be in opposition between January 1 and December 31, 1877. Most of the planets selected are of small magnitude, and the observations must, therefore, for the most part, be confined to those made with large equatorials, for it is found to be waste of time to look for the smallest of these planets with the present

meridional instruments. For this reason it is to be regretted that so few of the older and larger planets are not included in the selection. In 1877, though twenty-four brighter than the tenth magnitude are in opposition, only eight of them, including the four senior planets, have a daily ephemeris; and, consequently, sixteen of the brightest cannot be observed on the meridian during this year.

From an examination of the Table of opposition-magnitudes given for this year in the *Berliner Jahrbuch* for 1879, it will be seen that by taking the means of groups of twenty-five consecutive planets ranged in the Table in the order of their discovery, the lowest limit of magnitude has been, on the average, reached. In the Table, 125 opposition magnitudes are given. Forming these into five groups, the mean magnitudes are respectively 9.6, 11.0, 11.4, 11.4, and 11.3, and by subdividing the first group into two groups of ten and fifteen, the respective mean magnitudes are 8.7 and 10.1. It has also been found that when the same planets are ranged in the order of their mean distances from the Sun, the corresponding means bear a similar relation to each other.

Discovery of a New Comet.

After an unusually long interval since the detection of a new comet, M. Borrelly discovered one at Marseilles, early in the morning of February 9, 1877, in the constellation *Ophiuchus*. Its observed position at 3^h 41^m A.M., mean time at Marseilles, was R.A. 17^h 13^m, and N.P.D. 91° 17'. Its motion was rapid, increasing daily 44^m in R.A., and 3° 7' towards the north. It had a bright and round nucleus about 3'.5 in diameter.* The last discovered comet of unknown period was detected by M. Borrelly, on December 6, 1874.

D'Arrest's Periodical Comet.

In the *Comptes Rendus* (No. 9, Août 28, 1876), M. Leveau has given the final osculating elements of this interesting periodical comet, resulting from the investigation of which a brief abstract is given in the last Annual Report. This comet was discovered by M. D'Arrest, at Leipzig, on June 27, 1851, and will be in perihelion in May next. M. Leveau's investigation is based on the observations made at the former apparitions in 1851, 1857, and 1870, and he has previously published elements for the

* The announcement of the discovery of this comet was received by telegram from M. Stephan on the day of the Annual Meeting, in time to be inserted in this Report. The comet was independently observed by M. C. F. Pechüle, at Copenhagen, on the following morning.—E. D.

epoch 1869, October 13. By applying the perturbations produced by *Jupiter*, *Saturn*, and *Mars*, from this epoch to 1877, January 14, he has deduced the following corrected elements, from which a working ephemeris has been calculated for the convenience of observers at the approaching apparition. The new osculating elements are:—

Epoch 1877, January 14^o, M.T. Paris.

	°	'	"	
ϵ	= 301	56	54'42	} Mean Equinox and Ecliptic, 1880 ^o .
ω	= 319	9	14'70	
θ	= 146	9	27'63	
ϕ	= 15	43	9'22	
η	= 38	53	18'04	
n	= 540''	41003		

Perihelion passage, 1877, May 10^h 33^m 39^s, M.T. Paris.

The details of M. Levean's investigations will be published in the *Annales de l'Observatoire de Paris*.

Santiago de Chile Observations.

The observations made with the Meridian-Circle of the National Observatory at Santiago de Chile from 1856 to 1860, have lately been published under the superintendence of the former Director, Dr. C. W. Moesta, who had undertaken this duty since his return to Europe. They are contained in Vol. II. of the *Santiago Astronomical Observations*, and are given in the form of a catalogue consisting of 3,309 stars, mostly south of the equator. The reduction of the observations from apparent to mean place is given in detail for each star, and the mean Right Ascensions and north polar distances for 1860^o for each separate observation. The results are, therefore, not so available for general use in this shape as they would have been if they were collected, the means taken, and then formed into an ordinary catalogue of stars. But from the orderly manner with which the separate results are arranged, there is not much difficulty in forming, if required, a mean result for the epoch 1860, January 1.

The volume also contains observations of the Moon and Moon-culminating stars from January 15, 1856, to December 30, 1857, and also some observations of *Mars*, *Jupiter*, *Saturn*, *Uranus*, and *Neptune*, and of a few of the minor planets, made principally in 1856. The volume, which was printed at Dresden, concludes with a comparison of the Santiago Catalogue with those of Washington, Johnson, and Taylor.

Physical Observations of Saturn.

Mr. Trouvelot* has during the last four years had many opportunities of examining the planet *Saturn*, using the 15-inch refractor of Harvard College, the great Washington refractor, of 26 inches aperture, and the 6-inch refractor of his own Observatory, and from the observations thus made he has drawn the following conclusions, A and B denoting the outer and inner divisions of the outer ring, and C the outer portion of the interior bright ring:—

“1. That the inner margin of the ring B limiting the outer border of the principal division, has shown on the ansæ some singular dark angular forms; which may be attributed to an irregular and jagged conformation of the inner border of the ring B, either permanent or temporary.

“2. That the surface of the rings A, B, C has shown a mottled or cloudy appearance on the ansæ during the last four years.

“3. That the thickness of the system of rings is increasing from the inner margin of the dusky ring to the outer border of the ring C, as proved by the form of the shadow of the planet thrown upon the rings.

“4. That the cloud-forms seen near the outer border of the ring C, attain different heights and change their relative position, either by the rotation of the rings upon an axis, or by some local cause; as indicated by the rapid changes in the indentation of the shadow of the planet.

“5. That the inner portion of the dusky ring disappears in the light of the planet at that part which is projected upon its disk.

“6. That the planet is less luminous near its limb than in the more central parts, the light diminishing gradually in approaching the border.

“7. That the dusky ring is not transparent throughout, contrary to all the observations made hitherto; and that it grows more dense as it recedes from the planet; so that, at about the middle of its width, the limb of the planet ceases entirely to be seen through it.

“8. And, finally, that the matter composing the dusky ring is agglomerated here and there into small masses, which almost totally prevent the light of the planet from reaching the eye of the observer.”

Astronomers are much indebted to Mr. Marth for the continuation of his ephemerides of the satellites of *Saturn*. No observations have, however, been communicated to the Society during the year.

* *American Journal of Science and Arts*, No. 66, xi., June 1876.

Observations of Jupiter's Satellites at Adelaide.

Mr. Todd has employed his new 8-inch equatoreal, by Cooke, mounted in December 1874, in making a very valuable series of observations of the phenomena of *Jupiter's* satellites during the last opposition of the planet, extending from June 13 to October 15, 1876. He has recently forwarded to the Astronomer-Royal, for communication to the Society, a detailed statement of these observations, which consist of eclipses, occultations, and transits of the satellites, and also of the ingress and egress of the shadows. The local mean times of observation are given, as well as the corresponding Greenwich mean times, which are compared with the calculated times in the *Nautical Almanac*. Some notes on the physical appearance of the planet accompany the observations. A very interesting phenomenon observed more than once, independently, by Mr. Todd and by his assistant, Mr. Ringwood, occurred when a satellite was on the point of occultation. Instead of disappearing gradually behind the planet, it was apparently projected on the disk, as if viewed *through* the edge of the planet, supposing the latter were surrounded by a transparent atmosphere laden with clouds. This curious phenomenon was noticed on two occasions at the disappearance of the first satellite, when it was thus distinctly visible on, or through the edge of, the disk, for about two minutes before it was finally occulted.

Mr. Todd bears witness to the constantly varying aspect of the surface of *Jupiter*. He was much impressed with some sudden and extensive changes in the cloud-belts, as though a violent storm was raging, changing their appearance within an hour or two, or even less, not only in their form, but also in their magnitude.

Drawings of Jupiter.

Considerable attention has been directed during the last few years to the apparent changes on the surface of *Jupiter*, and a large number of careful drawings have been made from time to time. Some of these have appeared in the *Monthly Notices*, including the two interesting series communicated by the Earl of Rosse and Mr. Knobel. Following a suggestion of Dr. Lohse, of Berlin, the Council appointed a Committee for the examination of all drawings forwarded to the Society. In reply to a circular issued by the Committee, drawings from widely separated places have been received, and these have been or will be sent to Dr. Lohse, a member of the Committee, who has undertaken the collation of them. Forty-two delineations of the planet have been received from Mr. Hirst, of Sydney, and also a series of 153

drawings from Mr. Trouvelot, of Washington. Others have been forwarded by Professor Tacchini, of Palermo, Mr. Todd, of Adelaide, and M. Lehardelay, of Fontenay-le-Marmion. These drawings all show that very rapid changes are still going on upon the surface of *Jupiter*, though the character of the equatorial markings differ slightly from those shown upon the drawings of the planet made two or three years ago.

The Supposed Discovery of the Object perturbing the Motion of Procyon.

In former reports allusion is made to the observations of an object supposed by M. Struve to be a companion to *Procyon*, and which seemed, from a comparison of his observations with the theory previously deduced by Dr. Auwers, to be the object causing the observed irregularities in the proper motion of this star. The image of this supposed satellite is now found by M. Struve to have been produced by an optical illusion on his part, and also by his assistant, Herr Lindemann.

As long ago as the year 1844, Bessel remarked that the proper motions of *Sirius* and *Procyon* were subject to irregularities, which he conjectured must be due to the attraction of bodies in their vicinity, either not perceptible to us, or which, at any rate, had not yet been discovered. It is not necessary to allude further to the case of *Sirius* at the present time; but as regards *Procyon* the matter was put into a definite shape by Dr. Auwers, who in the year 1861 made a careful investigation of all the available observations, and showed that it was possible to reconcile the whole by the hypothesis that the motion of the star was disturbed by the attraction of an unseen object, about $1''\cdot2$ distant, round which it moved in a plane perpendicular to the line of sight, and in a nearly circular orbit, in a period of about forty years. For some time before this M. Otto Struve had been examining the star with the Pulkowa refractor, continuing his scrutiny without result till the 19th of March 1873, when he detected a very faint point of light following the star at a very small distance, nearly in the same parallel. As the point of light was also seen by his assistant, Herr Lindemann, M. Struve was confirmed in his belief of the objective nature of the phenomenon. He was, however, desirous that the suspected object should be looked for at other observatories possessed of sufficient instrumental power. He communicated his wish immediately to Mr. Newall, requesting him to turn his Cooke's 25-inch refractor upon it, but unfortunately Mr. Newall was absent at the time, and daylight soon afterwards prevented further investigation till the next spring. Meanwhile Dr. Auwers repeated his theoretical investigation, and calculated what change the apparent position of

the object ought to undergo in that time, supposing it to be really the disturbing cause of the proper motion of *Procyon*. The months of February and March 1874 were singularly unfavourable for astronomical observations owing to bad weather, but on the 9th of April and subsequent days the point of light was again seen, the observed position-angle corresponding with what Dr. Auwers had theoretically found that it should be.

Before these observations of M. Struve the star had been examined with the 26-inch refractor at the Washington Observatory, but without detecting a companion; however, on the 12th of November 1874, Mr. Alvan Clark thought he saw a small object in a different position from that seen by M. Struve, and on November 25 and 26 of the same year Professor Holden saw another object within $10''$ of *Procyon*, and also at a different position-angle from that seen at Pulkowa. On January 12, 1876, he and Professor Watson both saw this, and also two other faint points of light, all less than $10''$ from the star, and at different position-angles, both with respect to each other, and also to that announced by M. Struve. Professor Holden suspected a still fainter companion between one of these and *Procyon*. These additional observations induced M. Struve to re-examine the subject with great care, the result of which has been to convince him that the phenomenon he had seen had no objective existence, but was the effect of an optical illusion which causes him (and Herr Lindemann also) to see under certain circumstances a faint image, or point of light, at about $10''$ distance from a bright star, and nearly in a horizontal line with it. On the 17th and 18th of April 1876, he found this to be the case with the bright stars *Regulus* and *Capella*. On the 11th of the following month, both he and Herr Lindemann observed a similar point of light near *Arcturus*, which, however, they were unable to perceive again on the following night.

M. Struve intends to make some further experiments on the subject, as a warning against a species of optical illusion which has not hitherto received much attention. It is a very singular circumstance that the different position of *Procyon* in the telescope with respect to a vertical circle seems to have produced that apparent change of position-angle in the supposed satellite which, from its agreement with the theoretical investigation of Dr. Auwers, led M. Struve so strongly to believe that he had detected the body whose attraction was producing the observed variability in the proper motion of *Procyon*.

It is certainly more pleasing to record the confirmation of a supposed discovery than its withdrawal; yet the latter has occasionally to be done, as in the case of the unconfirmed satellites of *Uranus*, generally believed to have been seen by Sir W. Herschel, until disproved by modern observations. The present instance is interesting as showing the close scrutiny to which any astronomical observation is now subjected by the aid of other instruments of equal or greater power, and the consequent improbability of anything not really objective being long supposed to be so.

Photographs of Spectra of Stars.

In an oral communication to the Society at the December meeting, giving the substance of a paper presented to the Royal Society, our President, Dr. Huggins, gave an account of the important results he had obtained in the application of photography to the spectra of stars, a work which he first took up in conjunction with Dr. Miller in the year 1863. Dr. Huggins has obtained successful photographs of the spectra of *Sirius*, *Vega*, *Venus*, and the Moon, with comparison spectra of the Sun, taken the next morning on the same plate. The spectrum of *Vega* in particular shows seven strong lines in the ultra-violet extending from G to M of the Solar spectrum, and these are so well defined as to allow of accurate micrometric measurement. Dr. Draper has also for some time past been engaged on the same work, and has obtained photographs of *Vega* and *Altair*, showing bands or broad lines in the violet and ultra-violet regions, unlike anything in the Solar spectrum. He has also taken photographs of the spectrum of *Venus*, which show a weakening towards H and above that line of the same character as that which he has photographically observed to take place in the spectrum of the Sun near sunset.

New Double Stars.

A catalogue of fifty new double stars, discovered with the 11-inch refractor of the Cincinnati Observatory, has been circulated by Mr. Ormond Stone, the Director. It has been prepared by Mr. H. A. Howe, who has arranged the matter in a tabular and convenient form for reference, exhibiting the approximate R.A. and N.P.D. for 1880, with the precessions in both elements; the estimated position-angles, distances, and magnitudes of the components; and the date of the discovery of the duplicity of the star. The stars are included between 8° and 40° south declination, and the angular distances vary from less than one second to eight seconds of arc. The greater number of the stars are of small magnitude, averaging 8 and 10 for the two objects. A few of the principal components are of the sixth magnitude, while the smallest are registered as of the eleventh.

Mr. Burnham has continued his examination of the heavens with the view of detecting close double stars not before identified. How he has succeeded in this interesting field of research can be gathered from the catalogues of new objects the duplicity of which has been first noticed by him. These have appeared in various publications—first, in our own *Monthly Notices*, and subsequently in the *Astronomische Nachrichten* and the *American Journal of Science and Arts*. It would have been more

convenient to those who are in the habit of referring to previous results of double-star observations if a continuous series of catalogues, such as those of Mr. Burnham, had appeared from time to time in the same publication; and as the commencing catalogues of his series of measures are inserted in the *Monthly Notices*, some regret has been expressed that all of them had not been communicated to the Society.

From the large number of hitherto unknown double stars discovered by Mr. Burnham and other recent observers, it may be concluded that as their attention is now directed to the smaller classes of stars, it will be found that, like the minor planets, an almost inexhaustible field of discovery is open to any one having a good eye and a sufficiently powerful instrument. It is, however, important in the case of suspected binaries, that the angular positions and distances should be instrumentally measured, if possible, as mere estimated data should not be considered sufficiently accurate as the basis for any future determination of their orbits.

Micrometric Measures of Double Stars.

M. Dunér has recently published an important series of observations of double stars made at the Lund Observatory in the years 1867 to 1875, in the course of which nearly 2,700 observations have been obtained of some 600 stars selected chiefly from W. Struve's catalogue. The measures were made with a filar micrometer applied to a Fraunhofer equatoreal of 245 millimetres (about $9\frac{1}{2}$ inches) aperture, and 4.31 metres (about 14 feet) in focal length, and the periodic errors of the screw were carefully determined in 1876 at the end of the series of observations. Besides his own measures of distance and position-angle, M. Dunér has collated, under the head of Notes, at the end of the volume, the principal results obtained by previous observers, and has exhibited, in a tabular form, the changes which appear to have taken place, as shown by discordances from the mean. In a final table, a classification of the stars, according to the amount of relative motion of the components, is given, the largest class being that containing double stars which have not as yet changed their relative position. M. Dunér is still continuing his work on double stars, to which he hopes to be able to devote a much larger portion of his time than has been possible in the period to which these observations refer.

The following table, according to M. Dunér, shows the distribution of stars, with reference to their relative motion, since the date of the first observations:—

Class.	Motion.	Number of Stars.
	o	
I.	360	8
II.	180	8
III.	90	8
IV.	30	16
V.	10	46
VI.	Certain	55
VII.	Probable	51
VIII.	Insensible as yet	207
IX.	Nil, no physical connexion	11

A memoir by Mr. Knott, containing nearly 2,000 observations of about eighty selected double stars, has been lately communicated to the Society, and will be published in the *Memoirs*. In this careful work Mr. Knott has followed the excellent model of the *Celestial Cycle*, accompanying his results by descriptive and critical notes, in which (as also in M. Dunér's volume) particular attention is paid to the colour and magnitude of the components.

Doberck's New Elements of the Orbit of ω Leonis.

In a paper read before the Royal Irish Academy in April last, Dr. Doberck has given the result of his recent investigation of the orbit of ω *Leonis*, in which he has discussed with great completeness all the data at his disposal up to 1876. This star, one of the most remarkable of the double stars discovered by Sir W. Herschel, has occupied the attention of most of our double-star observers since its discovery, but its excessive closeness has made it a very difficult object to measure. For this reason, very great discrepancies are found in the observations, especially when they have been attempted with small telescopes. Notwithstanding these difficulties, the star has been carefully watched during the last fifty years, or from the time when W. Struve commenced his observations at Dorpat. The notes of the appearance of the two stars recorded by the different observers are very conflicting, for while Sir James South, in 1826, states that the components are of the sixth and ninth magnitudes, the small star being pale blue, W. Struve, about the same time, remarks that they differ but little in magnitude and are both yellow, the smaller being certainly of the deeper colour. On the other hand, M. Dembowski has more recently made them white. The change in the relative distances between the stars was noticed by Sir W. Herschel, who made notes in 1782 and 1783, that the distance between them was increasing;

in 1795, that they were half a diameter of the smaller star asunder; and in 1804, that the space between them was nearly a diameter of the smaller one. It was seen oblong by W. Struve, in 1836 and 1838, and single by Mädler in 1843. Winnecke, in 1858, and Engelmann, in 1865, were unable to separate the two objects.

Elements of the orbit have been calculated on several occasions, but no one has paid greater attention to this star than Professor Klinkerfues, of Göttingen. But the great difficulty experienced in obtaining accurate measures has created corresponding difficulties in the calculation of the orbit. A first investigation of Klinkerfues appeared in 1855 (*Ast. Nach.* No. 990); these were followed in 1858 by a second and revised system of elements (*Ast. Nach.* No. 1,127), both of which were intended to illustrate his method of determining the orbit of a binary star; and, lastly, in his *Theoretische Astronomie*, he has published a third series of elements determined on twelve annual means of measures made to 1867, by Herschel, W. Struve, Mädler, Secchi, and Engelmann. In determining these last elements, Professor Klinkerfues considered that he had used all the available measures, but Dr. Doberck points out that many additional measures had been made at the time, though many of them have only recently been published.

That the elements calculated by Professor Klinkerfues were imperfect, and required considerable modification to satisfy the observations, was very evident to those interested in the subject, as may be seen from the following remarks of M. Otto Struve: "The elements of the orbit of ω *Leonis*, calculated by M. Klinkerfues, in 1858, are still very defective. For 1870 his ephemeris indicates the distance as $1''.06$, and the direction as $10^{\circ}.9$, while our measures give respectively $0''.58$ and 52° . Probably the erroneous result of his calculations should be attributed chiefly to the uncertainty of M. Mädler's measures, which were employed to form the last normal place for 1853. Without doubt the period of revolution will turn out to be much shorter than that found by M. Klinkerfues."

Dr. Doberck, at the commencement of his investigation, selected the angles and distances observed by O. Struve, to form his interpolating curves, and thus construct an ellipse. He found all the points well represented, but the principal star was not included in the circumference, and he was not able to alter the curve in a justifiable manner, so as to get the star inside the ellipse. He "considered it therefore not unlikely that O. Struve's measures, though as accordant among themselves as could be expected from the large refractor, were perhaps not quite free from systematic errors, though corrections had been applied as deduced from observations of artificial double-stars." By this system of interpolating curves applied to all the observed angles and distances, and by varying them when required to satisfy the observations, Dr. Doberck has determined five different sets

of elements, of which the following are the last and definitive values :

			°	'
Node	...	...	148	46
γ	...	...	64	5
λ	...	...	121	4
e	...	...	0.536	
P	...	...	110.82 years	
T	...	...	1841.81	
α	...	...	0".890	

A comparison of the observed angles of position and distances, with those deduced from the preceding elements, is given, including all the known observations from 1782 to 1876. The residual errors appear small, and good evidence is shown that the measures are represented more closely by Dr. Doberck's new elements than by any of those previously published.

Dun Echt Observatory Publications.

Double-star observers will be thankful to Lord Lindsay for the publication of the first volume of the Dun Echt Observatory publications, which contains a summary or index of all the measurements of double stars included in W. Struve's *Mensuræ Micrometricæ* and appendices. The scarcity of the original volume, which is rarely found in the libraries of amateur observers, together with its inconvenient size, has induced Lord Lindsay to commence his series of publications with this very valuable and useful abstract, in which most of the information relating to Struve's measures is given. The compilation and arrangement of the catalogue, and the reduction for bringing up the epoch to 1875, have been performed by Dr. R. Copeland.

The separate columns of the catalogue contain the R.A. and declination for 1875; the lowest and highest powers used by Struve; the mean date of observation; the mean distance and position-angle as deduced by Struve; and the magnitudes and colours of the components; the latter translated from the Latin names. These translations of the colours were carefully considered, and then strictly adhered to. A table of the precessions in declination for ten years is also appended; and a diagram is given, from which the variable part of the precession in R. A. for ten years in minutes of time can be taken. The work is printed in quarto form, and has been most liberally distributed by Lord Lindsay among astronomers and scientific institutions.

The New Star in Cygnus.

A remarkable stellar outburst, similar to that which appeared in *Corona Borealis* in May 1866, was first noticed by Dr. Schmidt, at Athens, on the 24th of November last, at 5.41 P.M., in the constellation *Cygnus*, then near the zenith. The new star, when first observed, was of the third magnitude, and of a yellow colour, near ρ *Cygni*, where Dr. Schmidt is sure that no corresponding object existed on the evening of November 20. The sky was overcast at Athens on the three following days, and most probably the outburst appeared at its full brilliancy in the interval between November 20 and 24. At midnight on the latter day the light of the star was of greater intensity than that of η *Pegasi*, noted of the third magnitude by Argelander. Its position does not appear to be recorded in the usual catalogues of small stars; certainly not in those of Lalande, Weisse's Bessel, Bode, D'Agelet, or in the *Durchmusterung* of Argelander. From an observation made by Mr. Hind at Mr. Bishop's Observatory on December 13, its R.A. for 1876.0 is $21^h 36^m 50^s.41$, and its N.P.D. $47^\circ 43' 21''.5$.

Unfortunately, Dr. Schmidt's discovery was not immediately communicated to the Astronomer-Royal or to any other English astronomer, although a telegram was sent to Dr. Littrow, at Vienna, and probably to other Continental observers. The first information of the sudden appearance of the new star was only received in England in the second week in December, from the public notices inserted in the *Bulletin International* and *Comptes Rendus*. This neglect is much to be regretted, as there were eight favourable evenings at Greenwich before December 9, when spectroscopic observations might have been successfully made, and of these at least two were near the time of the star's maximum brilliancy. Principally for this reason, but also in consequence of almost continuous unfavourable weather afterwards, very few observations of the star have been made in this country. When seen by Mr. Hind on December 13, it had receded to the sixth magnitude, and was without a trace of colour. The observers in Paris were more fortunate in obtaining information, for the star was examined on December 2, during a brief interval of clear sky, by MM. Henry, Cornu, and Cazin, and estimated of the fifth magnitude. Under more favourable circumstances, on December 4, M. Cornu made some satisfactory observations of the spectrum of the star with the eastern equatoreal of the Paris Observatory, the magnitude on that day being estimated at 4.5. The spectrum exhibited eight detached bright lines on a luminous ground, with an almost complete interruption of the light between the green and the indigo. M. Cornu saw no dark lines; if they had existed they must have been very fine, and invisible owing to the faintness of the light.

Naming the bright lines according to their intensity by the

Greek letters α to θ , their positions in the spectrum, in relation to those of certain elements, may be readily seen from the numbers in the following table determined by M. Cornu :—

	α	δ	γ	β	ζ	η	θ	ϵ
Observed	661	588	531	517	500	483	451	435
Hydrogen	656 (C) ...	...	...	...	...	486 (F) ...	...	434
Sodium	...	589 (D) ...	...	...	...	...	...	...
Magnesium	...	...	...	517 (<i>b</i> mean)	...	...	...	...
Coronal line	...	...	532	...	...	...	...	...
Chromosphere lines.	...	587	...	...	...	...	447	...

M. Cornu remarks as an interesting fact, but one requiring confirmation, that there are several coincidences shown in the preceding table which have led him to the conclusion that the bright lines in the star-spectrum correspond exclusively with the principal lines in that of the chromosphere, and therefore that the light of the star possesses precisely the same composition as that of the Solar envelope. He says: "But the most curious result, which I give here with much reserve, but which it will be very interesting afterwards to verify, is the coincidence of the line γ , very bright in the spectrum of the star, with the green line $\lambda = 532$ (1474 of Kirchhoff's scale), observed in the spectrum of the Solar corona and in the chromosphere; the feeble band θ corresponds also with a band $\lambda = 447$ of the chromosphere; one is thus led to think that the line ϵ corresponds rather with the bright line of the chromosphere $\lambda = 587$ (helium), than with that of sodium, 589. If this interpretation be correct, the bright lines of the spectrum of the star comprehend exclusively the brightest and the most frequent lines of the chromosphere."

The spectrum of the star has also been examined by Padre Secchi, Dr. Vogel, and others, all of whom confirm generally the previous observations of M. Cornu. Several bright lines were seen by Dr. Vogel in the red, blue-green, and blue parts of the spectrum; bright bands were also visible in the yellow and green; but these may possibly be portions of a continuous spectrum seen bright by contrast with absorption bands, of which there were as many as eight or ten. The blue and violet were brighter than in most stars with band spectra. The bright lines c, f, and D_3 were visible; *b*, however, was probably not seen bright, but a bright line on the blue side was noticed, which may possibly be identical with a line which under peculiar circumstances is the brightest in the spectrum of hydrocarbon. One seen in the violet may be the third line of hydrogen. Dr. Vogel remarks that there are three other stars in *Cygnus* giving quite unique spectra.

By careful comparisons with several neighbouring stars, Dr. Schmidt noted the gradual diminution in the intensity of the

light of the star almost daily. The variations of magnitude are exhibited in the following table:—

November 24	3.0	Magnitude.	December 5	5.9	Magnitude.
" 25	3.1	"	" 7	6.3	"
" 26	3.1	"	" 8	6.5	"
" 27	3.2	"	" 9	6.6	"
" 28	3.8	"	" 10	6.5	"
" 29	4.7	"	" 11	6.7	"
" 30	5.0	"	" 12	6.7	"
December 1	5.2	"	" 13	6.8	"
" 2	5.4	"	" 14	6.9	"
" 3	5.6	"	" 15	7.0	"
" 4	5.8	"			

At the end of the year the star was still about the seventh magnitude, and of a decidedly orange colour, with a reddish tint.

Suspected Changes in Nebula Messier, No. 17 (the Horseshoe Nebula).

Professor Holden has made a very interesting comparison of all the available drawings of the well-known nebula Messier, No. 17,* with the object of ascertaining whether any visible changes could be detected in the relative positions of the nebula and neighbouring stars. The drawings are those of Sir John Herschel made in 1833 and 1837 with his 20-foot reflector of $18\frac{1}{2}$ inches aperture; of Lamont (1837) with the 11-inch Munich refractor; of Mason (1839) with a 14-foot reflector of 12 inches; of Lassell (1862) with his 4-foot reflector at Malta; Trouvelot (1875) with a $6\frac{1}{2}$ -inch Merz refractor; and Trouvelot and Holden jointly (1875), with the 26-inch refractor of the Naval Observatory at Washington.

To examine the question as to the motion of the nebula relative to the stars, Professor Holden has divided the drawings into three groups, the *first* consisting of those made before 1840; the *second*, of Lassell's beautiful delineation, to which a great weight is given; and the *third* of the two drawings made in 1875, one at Cambridge, U.S., and the other at Washington. To prove the existence of a change, he has considered it necessary and sufficient to show that there has been an alteration in the position of some prominent feature, such as the "horseshoe," in the interval between the epoch of the first group and the second; and that this apparent change is confirmed and con-

* *American Journal of Science and Arts*, No. 65, xi., May 1876.

tinued in the two drawings of 1875, greater weight being given to that obtained with the larger instrument. Professor Holden remarks: "It must be remembered that with two instruments of equal light, hardly more discrepancy in the positions of the *brighter* portions of the nebula is to be expected than in the star-positions, for these positions are determined by the stars themselves, and can be assigned with almost no error in a nebula which contains so many stars as the one under consideration. The fainter portions may vary greatly from the smaller to the larger instruments." Tables are given by Mr. Holden containing a comparison of the relative positions of the stars as laid down in the different drawings, which, on the whole, fairly agree; and in another table he has exhibited, in a convenient form, the evidence for or against a notion of the "horseshoe," with reference to its contained stars. As a final result of the comparison, he concludes that the tables show that the stars have remained in their relative positions from 1837 to 1875, and that "the drawings, whether taken as a whole or considered according to their relative importance, show that the 'horseshoe' has moved with reference to the stars, while the *Messierian* streak has not moved; and that, therefore, we have evidences of a change going on in this nebula. This may be a veritable change in the structure of the nebula itself, such as was suspected by Schroeter, confirmed by O. Struve, and again confirmed by myself in the nebula of *Orion*; or it may be the bodily shifting of the whole nebula in space, in some plane inclined to the line of sight."

Comparisons of other well-defined nebulae, on a similar plan to that adopted by Mr. Holden, would probably give us much information respecting the proper motions of different portions of nebulae. The difficulty of making accurate delineations of such delicate objects must, however, make us cautious in accepting any apparent changes in the position of nebulae in relation to neighbouring stars, unless they are confirmed by drawings of more than one observer at the beginning and end of each interval of time.

As bearing on this subject, it may be mentioned that a well-executed drawing of the nebula in *Orion*, reduced from a larger delineation, has been presented to the Society by Signor Tempel, of the Arcetri Observatory, near Florence. It is a valuable addition to the other representations of the same nebula already in the possession of this Society.

Montigny's Researches on Scintillation.

The Council have already noticed in a previous report the important researches of M. Montigny on the scintillation of the stars. In a paper contained in the "*Bulletins de l'Académie Royale de*

Belgique" (2me série, t. xlii., No. 8, Août 1876), M. Montigny has given an abstract of the results recently obtained by him from some further investigations on the same subject, especially in relation to the connection of the intensity of the scintillations with the variations in the conditions of atmospheric phenomena. This very interesting astro-meteorological question has occupied the attention of M. Montigny for several years past, the observations discussed in the present paper extending from October 1870 to August 1876. They were continued, with occasional interruptions, during this interval as often as the state of the weather permitted, and under the influence of varying conditions of the atmosphere, and of a different temperature, which in December 1870 and January 1871 and 1876 was as low as -9° and -10° centigrade.

The instrument employed was an astronomical telescope of 77 millimetres aperture, with a magnifying power of 85. A scintillometer, formed of a circular plate of thick glass, was mounted obliquely in the tube of the telescope, in front of the eye-piece, and having a circular motion by means of a contrivance placed outside the telescope, by which the exact number of revolutions which the plate makes in a second of time can be ascertained. By this arrangement the image of any star towards which the telescope may be directed describes a perfect circumference in the field of the instrument. When there is no scintillation, the circle forms a continuous line presenting the general tint of the star, but when it is visible, this circular curve is broken into coloured arcs, varying rapidly, among which may ordinarily be detected red, orange, yellow, green, blue, and occasionally violet, according to the character of the scintillation. By means of a micrometer-wire placed in the focus of the telescope, the number of coloured arcs contained in the curve described by the stellar image is obtained and the amount of intensity determined. About seventy stars were selected for the experiments, varying from the first to the fourth magnitudes, and they are included in the three principal types, according to Padre Secchi's classification. The stars observed on each evening were those situated in the eastern and western portions of the heavens, and owing to the continuity of the observations this method of selection had the effect of obtaining results for each star, when situated in opposite quarters of the sky, at intervals of several months.

M. Montigny gives a series of tables of comparison between the intensities of scintillation and different meteorological data, determined from observations made at the Observatory of Brussels. The tables exhibit the intensities ranged in order of the seasons, of single rainy days, of consecutive rainy days, of days of high wind and storms, etc., leaving a comparison of other data in relation to the temperature of the air, atmospheric pressure, and some other phenomena, for another paper. Important results are shown in these comparison tables; among them it may be noticed that in some seasons it was found that the intensity of

scintillation is decidedly greater in rainy than in dry weather, and more marked in winter than in summer, about equal in spring and autumn in dry weather, but in general wet seasons the intensity is greater in spring than in autumn. On stormy nights the scintillation increases or diminishes in intensity with the rise and fall of the barometer, being greatest on the approach of a storm, and again diminishing as it passes away. Other facts have been satisfactorily brought out, but these are sufficient to show that most interesting results have been obtained by M. Montigny from his systematic series of observations.

Progress of Meteoric Astronomy during the year 1876.

The records of meteoric phenomena during the past year comprise a few falls of aërolites, the occasional appearances of several considerable fireballs, and a few observations relating to periodical star showers, and to radiant points of meteor showers occurring with less intensity on ordinary nights of the year.

Of meteorites whose fall was witnessed, and specimens of which have been preserved, the following brief list supplies the localities and dates, and some of the particular characters of the aërolitic falls :—

Date.	Local M.T.	Locality, and Remarks.
1875, Sept. 14	4 ^h p.m.	Supino, Circ. Frosinone, Italy (Stone fall).
1876, April 20	3 ^h 40 ^m p.m.	Rowton, near Wellington, Salop, England (Iron-fall, 7 $\frac{3}{4}$ lbs.).
1876, June 28	11 ^h –12 ^h a.m.	Ställdalen, Dalecarlia, Sweden. Three or four stones fell—the largest 4 $\frac{1}{4}$ lbs.

Aërolitic falls of less importance, or of which the occurrences are less authentically reported, have also taken place on the following dates :—

Date.	Local M.T.	Locality, and Remarks.
1876, June 25	9 ^h –10 ^h a.m.	Kansas City, Missouri, U.S.A. No meteor seen; but a small stone, weighing a few ounces, fell—too hot to be touched imme- diately—on the tin roof of a house, which it almost penetrated, and bounded off.*
1876, July 8	4 ^h a.m.	Louisville, Kentucky. A stone fell, accom- panied by a report, in the streets of the town, weighing about 2 lbs.†

* *Amer. Journ. of Science*, vol. xii., p. 316; October 1876.

† *Louisville Courier Journal* (*Scientific American*, of Aug. 12, 1876, p. 98).
A large meteor (see below, p. 211) was seen on the same date in Indiana.

Date.	Local M.T.	Locality, and Remarks.
1876, Oct. 19	2 ^h a.m.	Newburyport (Mass.) and Ledyard (Conn), U.S.A. A large fireball seen at the former place; and numerous meteoric stones were found at the latter place on the day following its appearance.*

Among these meteorites, the Rowton aërosiderite is particularly interesting, as it is only the seventh example of a solid iron meteorite whose descent has been witnessed, and of which a specimen has been preserved. It fell in rainy weather, unaccompanied by any visible fireball, but preceded by two startling detonations heard northward from the Wrekin over the neighbouring villages of Shropshire for many miles. It penetrated the soil of a turf-field to a depth of eighteen inches, almost vertically, but with a slight inclination (from the north-west towards south-east), and when discovered about an hour after the occurrence it was still quite warm. It was presented to the British Museum by his Grace the Duke of Cleveland, in whose property it fell; and a cast of the meteorite may be compared with similar casts of the iron meteorites of Braunau, Victoria West (S. Africa), Nidigullam (Madras), Marysville, and Charlotte (Dickson Co.), U.S.A., of which, with that of Agram, in Croatia, the actual falls have previously been witnessed. The meteorite itself is undergoing section and preparation for an analytical examination of its composition. The stone-fall at Supino, in Italy, on September 14, 1875, happened on the same day as the appearance of the large detonating fireball in England described in last year's Report (*Monthly Notices*, vol. xxxvi., p. 216), and the coincidence appears to be particularly deserving of attention, as it was stated in the *Bradford Times* (*Nature*, September 23, 1875), that the detonation which followed the meteor's appearance at that place was so loud as to be plainly heard indoors by those who had not seen the meteor, which more clearly established its aërolitic character than had been suspected in last year's Report. The coincidence of a stone-fall on the same date, if not purely accidental, raises a reasonable conjecture that it may have belonged (with the aërolitic fireball simultaneously observed) to a shower of ordinary shooting stars whose approximately known radiant point was found to agree exactly with the true course or direction of flight of the detonating meteor; for it will be remembered that a comparison of many well-accordant descriptions of its apparent path extensively observed in England enabled the true direction and the real path of the large fireball of September 14, 1875, to be determined with more than ordinary certainty and precision.

* *New York Observer*, Thursday, Nov. 9, 1876. The asserted fall of a small stone, apparently meteoric, stated in *Nature*, vol. xv., p. 305, to have been observed at Ecclesfechan, near Glasgow, on the evening of Jan. 2, 1877, may be added to the above list of supposed falls of aërolites recently recorded.

The fireballs of large size which have been recorded during the past year may be briefly noticed here under three separate descriptions. Among the first, or detonating class, the following appear to have been the most conspicuous examples :—

Date.	Wash. M.T.	Locality, and Remarks.
1875, Dec. 27	9 ^h -9 ^h 20 ^m p.m.	Kansas, Missouri, and Iowa States, U.S. A large fireball bursting into many fragments, and leaving a luminous smoke-track, visible for 15 ^m , commenced its course over Nebraska, 120 miles west of Missouri R., and exploded, with heavy detonations, over Missouri State. Real motion due eastward, with a steep inclination towards the Earth.
1876, Jan. 5	10 ^h 30 ^m p.m.	Iowa and Missouri, U.S. A large and brilliant fireball, exploding with many thunder-like reports. Its true course was nearly vertically downwards from north-west towards south-east.
1876, Jan. 31	5 ^h 30 ^m p.m.	Louisville, Kentucky, and Tennessee, U.S. A large fireball observed by Dr. Lawrence Smith; said by some observers to have been followed by sounds of an explosion.
	Local M.T.	
1876, June 15	8 ^h 10 ^m p.m.	Suez to Port Saïd. A large fireball, which burst with a very loud explosion, illuminating the sky brightly at all the stations on the Maritime Canal; moving from west to east, or from south to north, vertically over the <i>Déversoir</i> , and leaving a light streak there at the point where it exploded.

A large fireball which was perhaps also detonating (*see* below, p. 211) was observed in France at about 9^h p.m., on November 5, 1876. In the second class of fireballs may be included those which have been sufficiently observed in England to afford means of determining, at least approximately, the real height and position of their tracks, and the real direction or apparent radiant-point from which they took their flight. The following list comprises all the comparisons of this kind which have been obtained from the best available descriptions, and it relates in general to those fireballs which have been most generally observed in England during the past year :—

Meteor's Real Course (distances in E. S. Miles).

1876, Date and Hour, G. M. T. Size and General Appearance.	Places of Observation (available for calculation).	Meteor's Real Course (distances in E. S. Miles).			Nearest known Radiant-point.
		Beginning : Height and Locality.	End : Height and Locality.	Radiant-point, observed. α δ	
July 25, 10 ^h 5 ^m p.m. Head 15' $\times$ 30'; green or red, with long tail of blue sparks; left no streak. (London and S. of England.)	Poplar (London) and Street (Somerset); corroborated by Hersham (Surrey) and Mai- denhead (Berks). An obser- vation at Brighton describes the meteor's path as so strongly inflected at the middle as to be wholly un- conformable in the first half, although agreeing well with these accounts in the last half of its flight.	62 miles over W. pt. of Guernsey (com- menced as a small shooting star 90 miles over Brit- tany, in France, by Poplar observation of its initial point).	27 miles over Crick- dale (Wilts), near Cirencester; length of path 107 miles in "5 or 6" (Street), or (?) nearly 200 miles in "about 6 secs." (Poplar ob- servation.)	$258^{\circ} - 24^{\circ}$ (near <i>Antares</i>). From the Poplar and Somersetshire observations. $250^{\circ} - 35^{\circ}$ Aug.; Λ_3 , Neumayer. $266^{\circ} - 42^{\circ}$ Aug.; Schmidt. $259^{\circ} - 36^{\circ}$ Aug. 5; δ 568 II. Ω .	$258^{\circ} - 20^{\circ}$ July; O_2 , Neumayer. $245^{\circ} - 30^{\circ}$ July; Schmidt. $262^{\circ} - 33^{\circ}$ July 23; δ 568 II. Ω .
Aug. 11, 11 ^h 22 ^m p.m. Bright as the full Moon; left a streak for 1 m., 10° long at Cardiff, curving at last like a sickle (Credition, Devon).	Radcliffe Obs., Oxford, with Credition and Sunderland; corroborations at Clifton, and Writtle (Essex).	73 ($\pm$ 8) miles over a point 9 miles W. of Ludlow, Salop.	45 ($\pm$ 5) miles over a point midway be- tween Neath and Llandoverly (Caer- marthen, S. Wales).	$60^{\circ} + 51^{\circ}$ ($\pm 2^{\circ}$) (near Λ <i>Perssei</i>)	An erratic <i>Perssæid</i> . Length of path, 58 miles in "1 second" (Oxford).
Aug. 13, 9 ^h 27 ^m p.m. About as bright as <i>Ve-</i> <i>nus</i> ; left a streak for 5 or 6 secs.	Buntingford (Herts), Folke- stone, and Radcliffe Obs., Oxford; the last for point of first appearance only.	90 miles over Wal- ton (near E. Dere- ham, Norfolk).	40 ($\pm$ 4) miles over Potters Bar, be- tween London and Hertford.	$39^{\circ} + 66^{\circ}$ ($\pm 2^{\circ}$) (near <i>Cassiopeidæ</i>).	Erratic <i>Perssæid</i> . Length of path and height at commencement un- certain; about 82 m. in "2 seconds" (Bun- tingford).

Aug. 15, 9^h 30^m p.m.
A fine fireball; yellow to blue or green, with long train, and some white streak remaining. Brilliant over Wales and Ireland; long, slow path; no terminal explosion.

69 miles over a point 10 miles W. of Gresholm Isle, Saint Bride's Bay (South Wales).

34 miles over a point 15 miles W. of Arklow (Ireland). 75 miles in "9 secs." (Newtown; 20 or 30 secs., Bath.) [By Irish and Manx descriptions pursued its course to 15 miles above the centre of Ireland, near Mullingar. Path about 130 miles?]

The apparent path much superposed, and radiant-point only slightly defined from δ *Aquarii* to $\frac{1}{2}$ ($\theta\lambda$) *Antinói*; the adopted radiant is the middle point of this line.

Sep. 24, 6^h 30^m p.m.
Two maxima, the last much brighter than full $\mathcal{D}$; streak on last part 16 min.; white, globular, no sparks. Seen at Hull, and in Paris. Illumination over the English Channel most intense.

Orwell Park Obs. (Ipswich); St. Pierre (Dunkirk Railway), Broadstairs, Deal, Great Marlow, Dymock, (Hereford), and other generally corroborating descriptions.

16 miles over a point 15 miles N. of Ostend.
285° + 35° ($\pm 5^\circ$) (near δ *Lagæ*).

No good accordance with any previously known radiant-point. Course nearly vertical, descending at an inclination of $\frac{1}{2}$ about 15° or 20° from S.S.E. towards the N.N.W.

1876, Date and Hour,
G.M.T.
Size and General
Appearance.

Nov. 8, 5^h 4^m p.m.
Large and bright, even
in the twilight; fire-
colour, with long train
and string of globes at
last; left no streak.

Places of Observation
(available for calculation).

Wimbledon (Surrey) and Hay
(S. Wales) for end-point
and radiant-point. New
Cross (London), and other
corroborations in the S. of
England. Long, nearly ho-
rizontal course of 240 or 300
miles (?) in "4 or 5 secs."
(Wimborne, Hants; no es-
timates are recorded of its
entire duration.) Leisurely
horizontal motion "towards
S. or S.W.," at every place;
(towards W. at Manchester).

Birmingham, Putney Hill,
and neighbourhood of Lon-
don (the exact place not
specified).

1877, Jan. 7,
10^h 31^m 30^s p.m.
= ♀; yellow, and red
sparks in train. Long,
slow, irregular course;
died out; left no
streak.

Meteor's Real Course (distances in B. S. Miles).

Beginning: Height and Locality.	End: Height and Locality.	Radiant-point, α observed.	Nearest known Radiant-point.
50 miles over Shef- field, or 55 miles over Hull and Horn- sea (alt. 20° due N. from London. This early com- mencement, and the length of flight at last, are some- what inconsistent with other obser- vations).	37 miles over the Irish Channel, 60 or 70 miles W. of Milford Haven. An earlier termination of the meteor on this line of flight, over Aberystwith is indicated by a good observation of its apparent course at Manchester.	$53^\circ + 20^\circ$ $(\pm 5^\circ)$ (near η <i>Tauri</i>).	A <i>Taurid</i> . The whole real course is pre- sumptive, assuming the observed altitude at Hay 20° or 25° due West to be measured and accurate. The adopted general rad.- point, however, ad- mits of very little va- riation or correction.
76 miles over Staple- hurst, Kent. First expansion at 67 miles over the chan- nels of the Thames and Blackwater River, Essex (end and beginning points as seen in London).	33 miles over the North Sea, 25 miles N. and 90 miles E. from Cromer, Nor- folk (Birmingham termination).	$44^\circ - 16^\circ$ to $65^\circ - 13^\circ$ (near γ <i>Eri- dani</i> ; not conformable to any known meteor- shower).	Length of path 104 miles (London); 185 miles (Birmingham, ? overrated; and dura- tion "5 to 6 secs." there). Theoretical meteor speed 12.3 miles per second.

In addition to the above accordant observations, simultaneous records of 15 or 20 bright meteors and shooting stars, chiefly between Mr. W. F. Denning's station at Bristol, and the Radcliffe Observatory, Oxford, have been obtained, of which the particulars will afford available materials for calculation. The times of appearance and general description of other considerable meteors during the past year, as far as accounts of them have been received, appear to have been as follows:—

1876, Feb. 4	Date. 7 ^h 35 ^m p.m.	Nucleus with globular disk several minutes in diameter; seen moving slowly westwards, in the south, at Bristol.
1876, Mar. 19	Paris Time. 11 ^h 13 ^m p.m.	Fireball recorded by M. Chapelas Coulvier Gravier, at the Observatory of the Luxembourg, in Paris.
1876, April 15	8 ^h 33 ^m p.m.	Meteor with a bright disk; seen in the western twilight at Bristol, and at Hawkhurst (Kent).
1876, July 8	Wash. M.T. 8 ^h 45 ^m p.m.	Indianapolis, and Indiana State, U.S. A fireball of the largest class; half the appar. diam. of the Moon, leaving a streak of light for 40 ^m ; no detonation heard. Traversed an arc of 30° north-westwards from <i>Cassiopeia</i> .
1876, Aug. 21	8 ^h 10 ^m p.m.	Bolide with large elongated nucleus. Manchester; and at London and Sheerness. (Fell in the north.)
1876, Aug. 22	8 ^h 40 ^m p.m.	At Scarborough; very bright. Fell in the E.S.E. nearly to the sea, from alt. about 60° in the S.E.
1876, Nov. 5	Paris Time. 8 ^h 40 ^m –9 ^h p.m.	Large fireball. Departments of Marne and Aube, France; a detonation is said to have been heard in the latter district at Clery. At Choisi-le-Roy the meteor's course was from <i>α Aurigæ</i> to <i>α Ursæ Majoris</i> , and along this line it left a momentary streak. The meteor's course is directed from <i>Taurus</i> and <i>Auriga</i> .
1876, Nov. 6	5 ^h 45 ^m p.m.	A large fireball at Orsay, Paris, moving slowly at a low altitude in the E.N.E. southwards. Bright, but smaller than the Moon's disk, leaving a slight streak on its course. Very probably a "Taurid" seen with slow foreshortened course near its radiant point.

- 1876, Nov. 6 Between 8^h-9^h p.m. A large meteor seen in Kent, Herts, and Lancashire, descending almost vertically in N. and E. (Kent and Herts), and in the West (Lancashire); (?) two meteors. Divided into two parts, or disappeared with two separate explosions. Not directed from *Taurus*.
- 1876, Nov. 7 7^h 19^m p.m. Fireball in *Capricornus*; Writtle (Essex). Burst with a bright flash 6° under β *Capr*. Path 10° in 3 seconds, directed from *Saturn*. Very probably a distant "Taurid."
- 1876, Dec. 13 4^h 45^m p.m. A bright fireball, in daylight, when very few stars were yet visible; seen from near London, Farnborough (Hants), &c.; in the N.E. descending from west to east with a course of some length to near the E. horizon. Yellow, bluish green, and red at last, with a trail of sparks, which remained visible for a few moments. The descriptions of this fireball's course correspond very nearly with that of the daylight meteor of December 22, 1875, at 1^h 40^m p.m., described in the last volume of these *Notices*;* and it appertains not improbably to a meteor-system of the same group, with a radiant-point near β *Herculis*.

Of the real courses of the many bright meteors here described very little is accurately known, and it is much to be desired that in describing apparitions of such remarkable phenomena observers would endeavour to ascertain correctly and express clearly the apparent positions in the sky of the tracks along which these celestial intruders upon the Earth in its motion round the Sun pass across their field of view.

The periodical star showers of the past year have been either inconspicuous or much concealed by cloudy weather, and scarcely any notes of them of very remarkable importance were obtained. A meteor shower of some intensity was observed on the night of the 18th of April 1876, at Bloomington, Indiana, U.S., of which the appearance was recorded, and some particulars were gathered by Professor Kirkwood, of the State University of that town. The meteors were sufficiently numerous and bright to attract the attention of ordinary observers, and from their description the radiant point of the shower appears to have been in the neighbourhood of the constellation

* Vol. xxxvi., p. 217.—*Erratum*: line 19 from bottom of the page, for *Brangling*, read *Braughing*.

Lyra. As the year was a leap-year the expected time of appearance of the shower would be on the 18th instead of on the 19th-20th of April as it returns in ordinary years. Another meteor shower of greater brilliancy was observed on the night of October 18, 1876; and its appearance was similarly recorded by Professor Kirkwood from the concurrent testimonies of numerous observers of the many bright meteors which were visible at Bloomington on that night. The radiant-point was in *Auriga* or between *Taurus* and *Auriga*, and it may not impossibly have been distinct from the usual maximum recurrence of the well-marked shower from *Orion* on that date. From the narrative (above quoted) of the appearance of a large meteor (perhaps aërolitic) early on the following morning in Massachusetts, it may also be added that frequent small shooting stars were still visible there at 2^h a.m. on October 19, and it is said that two or three of the shooting stars seen at Bloomington between 9^h 45^m and 11^h 15^m p.m. on the 18th were noticed to be exceedingly conspicuous by their size and brightness. Of these and other star showers, with the exception of that of August last, no observations were obtained in England. The sky was clear during the period of the August shower, but the Moon had scarcely passed its full, and was unfavourable to observations in the later hours. The maximum of the shower occurred on the night of the 10th, and it was so unimportant in intensity compared with many previous displays that one observer watching a clear sky could at the most only count about 25 or 30 *Perseïds* per hour together with 10 or 12 sporadic shooting stars, while the numbers seen on the nights of the 9th and 11th were much less than this. Even allowing for the effect of the Moon's light in extinguishing the smallest meteors of the *Perseïd* shower, the observations all indicated very clearly a distinctly marked diminution in the intensity of the August showers in 1876 as compared with its brightness in 1875, and in several of the immediately preceding years. Among the records of the shower in England are several simultaneous observations, two of them of bright *Perseïds* (on August 11 and 13) and one of an *Aquilid* or *Aquariad* on the 15th, of which only a few calculations (those above described) have yet been brought to a conclusion. The radiant point of the shower was accurate, in spite of its faintness, near η *Perseï*; but the presence of another radiant point in *Cassiopeia* was also recognised on certain nights of the shower as exhibiting simultaneously with it a very marked activity, which scarcely, however, permitted its position to be very accurately determined. Watches were maintained without success at well-equipped stations and under favourable conditions of the sky for the *Leonids* and *Andromedes* of November 1876. At Clermond Ferrand, in France, Mr. Gruey, assisted by one companion during a part of the watch, saw only five meteors on the first and even fewer falling stars on the second morning during intervals of four hours' duration, each

after midnight a.m. of November 13 and 14, although the sky was clear. During the hour from 2^h 30^m to 3^h 38^m on the morning of November 15, when the sky was very clear, only one meteor was observed. None of these shooting stars appear to have been conformable to the radiant point in *Leo*. The observations of the same shower in 1875, including those communicated last year to the Astronomical Society by the Astronomer-Royal,* clearly indicate that the November shower has ceased to be conspicuous on the accustomed dates; but a progressive tendency of the shower to reach its maximum on the morning of the 15th instead of the 14th of November, observable in the years ending with November 15, 1872, is noticeable in all more recent observations of the *Leonids*, and may have continued to retard its date, unperceived by observers on the ordinary nights of observation, since that time. Three small *Leonids*, leaving white streaks for two or three seconds, seen near the radiant point in *Leo* by Mr. Denning, at Bristol, on the morning of November 19 (with two others on the following morning), diverging accurately from a point at R.A. 149°, Decl. +22° †, together with the absence of any such indications of the shower in France on the mornings of the 13th-15th of November last, may perhaps be accounted for by a considerable deformation of the meteor stream, and a consequent sensible change of position of its nodal points, in the portions forming the terminal or retreating phases of the shower.

No indications of the *Andromedes* were observed by Mr. Denning on later mornings of November, and a watch for them kept at other stations on the last few evenings of the month, when the sky was clear, was also without success. The shower of the "Geminids" of December 12 appears to have furnished a large proportion of shooting stars as early as December 8 and 9; but cloudy skies on the following nights prevented the time of its maximum from being ascertained. No observations on the periodic shower-date of January 1-3, 1877, have yet been received, and it is to be feared that the unfavourable conditions of the full Moon and cloudy weather have again prevented this rarely distinguishable star shower from being satisfactorily observed.

The observations of shooting stars at the Radcliffe Observatory, Oxford (included in the publications of that Observatory for the year 1874), continued to be recorded with accuracy and amplitude during the past year; and fifteen of the meteors registered are identifiable with meteors of various magnitudes which have

* *Monthly Notices*, vol. xxxvi., p. 272, March 1876.

† For easy representation of the lengths of paths, altitudes, and azimuths of meteors, etc., in degrees, it is found convenient to employ this mode of reckoning R.A. instead of the usual method of expressing it in time, and to describe declinations north or south of the Equator with a + or - sign, as a brief way of recording the apparent paths, and hence also most conveniently in charts of this description, the positions of the radiant points of shooting stars.

been elsewhere observed, and whose real paths it will be possible to compute with some precision. The Luminous Meteor Committee of the British Association has resumed its examination of these and of other meteor tracks communicated to it by observers, with a view to presenting in the most convenient form for their constant reference a table and map of the centres or regions of divergence of shooting stars on ordinary nights of the year, at present known with the greatest certainty to exist; and a key-map and table, constructed for this purpose by Mr. Greg, were presented, with the Report of the Committee, to the British Association in September last, as the first completed stage in the progress of their undertaking. It is also intended to embody the catalogue and map with the original lists of meteor showers by individual observers from which it is constructed, in a suitable tract or pamphlet, with instructions for recording, and directions of the days most desirable for registering shooting stars, to serve observers as a useful ephemeris to guide them in their observations; and this design the Committee hopes during the coming year to be able to carry out.

Report of the Auditors.

The following Report of the Auditors was presented to the meeting at the conclusion of the reading of the Report of the Council, in conformity with bye-law No. 65. The balance-sheet of the Auditors, however, differs in arrangement in some minor particulars from that of the Treasurer, presented to the Council and printed in their Report, but the balances in hand as stated in the two balance-sheets are precisely the same.—[E. D.]

“We, the undersigned, being the Auditors appointed, at the meeting of this Society held on the 12th of January last, to examine the accounts of the Society, in pursuance of the 65th bye-law, for the year ending 31st of December 1876, do report as follows:—

“1. The paper writing hereto annexed and marked A, and verified with our signatures, contains a true and correct statement of the receipts and expenditure of the Treasurer, on account of the Society, from the 1st of January to the 31st of December 1876, inclusive.

“The available balances in the hands of the Bankers and the Secretary of the Library Committee amounted to the sum of £270. 15s. 5d.

“2. The paper writing hereto annexed and marked B, and also verified with our signatures, contains a true statement of the funded property of the Society on the same day, as far as we are able to ascertain it.

“3. We have examined, as far as circumstances would permit, the state of the rest of the property of the Society, consisting of

“Instruments;

“Books in the Library;

“Stock of the Society's Publications.

“With regard to the instruments, we have to report that some of them, viz. Nos. 11, 21, 32, 64, 66, 68, 71, 73,* and 79 in the list contained in the Report of the Council in 1876, are missing. The remainder, including Nos. 28 and 49 in the same list, which have been found since that report, are, with few exceptions, in good order and preservation. We have not thought it necessary to enter into minute particulars on this subject, as a very careful examination of them was made previously to the last general meeting by Mr. Lecky, the principal part

* No. 73 has been removed from the list of the Society's instruments by order of the Council.—[E. D.]

of whose report was inserted in the *Monthly Notices* of February last.

“As no catalogue of the books in the library has been formed, we are unable to say whether they are correct in point of number. We strongly advise, in the general interest of the Society, that a catalogue should be made as soon as possible.

“We have had the same difficulty in dealing with the stock of the Society’s publications as was mentioned by the Auditors of last year, though not by any means to the same extent. It is, and always will be, exceedingly difficult to check the issue of individual copies of each of the *Memoirs* and *Monthly Notices*, but they are now in a very much better state than at the last audit. The perfect volumes have been carefully packed in parcels, with the number of copies contained marked on each. We have not examined the whole, but have opened some half-dozen, selected by chance, and have in every instance found the number to correspond with the label.

“FRANCIS BARROW.

“ARTHUR BREWIN.

“J. KENNEDY ESDAILE.

“February 8, 1877.”

RECEIPTS.

[illegible]

EXPENDITURE.					A.		
Salaries :—					£	s.	d.
Editor of <i>Monthly Notices</i> (five quarters) ...					75	0	0
Assistant Secretary (five quarters) ...					187	10	0
					262 10 0		
Income Tax and House Duty ...					5 5 0		
Fire Insurance ...					7 16 6		
Printing :—							
Spottiswoode & Co. ...					364	8	0
Hazell, Watson, & Viney ...					187	12	0
Holdgate Bros. (printing plates) ...					18	5	0
					570 5 0		
Lithography, Engraving, &c. :—							
Chatham School of Photography ...					5	10	0
W. H. Wesley ...					51	2	0
					56 12 0		
Binding and Stitching: J. Rumfitt ...					39 17 3		
Library expenses, binding books, &c. ...					138 14 6		
Turnor Fund: Books purchased during year ...					48 16 3		
Miscellaneous :—							
House expenses ...					28	7	7
Wages ...					23	17	0
Stamps and postage ...					49	10	8
Carriage of books and parcels ...					8	8	2
Stationery and office expenses ...					8	6	0
Expenses of meetings ...					17	15	6
Coals and gas ...					74	19	9
Mrs. Jackson-Gwilt's annuity ...					8	19	0
Fittings in Library &c.: Whitechurch Bros. ...					5	14	6
Sundries ...					20	19	8
Bankers' commission &c. ...					0	0	6
New Cheque-book ...					0	8	4
					247 6 8		
Investments :—							
Purchase of £300 Consols, at 96 $\frac{3}{8}$, including							
Commission ...					289	10	0
Purchase of £200 Consols, at 95 $\frac{1}{8}$, including							
Commission ...					191	10	0
					481 0 0		
Balance at Bankers', Dec. 31, 1876 ...					253	1	10
In hand of Secretary of Library Committee:							
On account of Library expenses ...					13	8	6
,, Turnor Fund ...					22	3	9
					288 14 1		
					£2,146 17 3		

FRANCIS BARROW.
ARTHUR BREWIN.
J. KENNEDY ESDAILE.

*Papers read before the Society from February 1876 to
February 1877.*

1876.

- Mar. 10. The Stereo-Micrometer. Prof. Zenger.
Occultation of the *Pleiades* observed at Madras on
Jan. 7, 1876. Mr. N. R. Pogson.
Abstract of Prof. Christian Mayer's paper on the
Observations of Binary Stars discovered at the
Mannheim Observatory, Mr. S. M. Drach.
On the proper Motions of the two components of the
Binary system *α Centauri*. Mr. E. J. Stone.
On a supposed Variability of the Proper Motion of
B.A.C. 793. Mr. E. J. Stone.
Micrometer-measures of *Saturn's* satellites made at
the Royal Observatory, Greenwich, in the year
1875. The Astronomer-Royal.
Comparisons of recent and former Observations of
B.A.C. 793, and remarks on the alleged Variability
of its proper Motion. Mr. Dunkin.
Note on a Starlit Transit Eye-piece. Dr. Royston
Pigott.
Observations of the November Meteors made at the
Royal Observatory, Greenwich, in 1875. The
Astronomer-Royal.
Preliminary Note on Photographing the least re-
fracted portion of the Solar Spectrum. Capt. W.
de W. Abney.
Reference Catalogue of Astronomical papers and
Researches. Mr. Knobel.
12. On the most probable Result which can be derived
from a number of direct Determinations with
assigned Weights. Mr. E. J. Stone.
A list of Stars beyond the ordinary limits of Distance,
inserted as double in Sir John Herschel's General
Catalogue of Double Stars. M. Flammarion.
Radiant Points of Shooting Stars. Mr. W. F.
Denning.
Near approach of 47 *Geminorum*. Rev. S. J. John-
son.
An Instrument for determining Spherical Triangles
by Mechanical action. Mr. F. C. Penrose.
Note on the two exterior Satellites of *Uranus*. Rev.
T. W. Webb.

- May 12. On our Sidereal System, and the Direction and Distance to its Centre. Mr. J. Ennis.
 Note on the Conjunction of *Venus* and λ *Geminorum* on August 17-18, 1876. Mr. Dunkin.
 On recent American determinations of Geographical positions in the West Indies and Central America. Major H. S. Palmer.
 A Catalogue of red double Stars. Mr. S. W. Burnham.
 Observations of Minor Planets made at the Observatory of Marseilles. M. E. Stephan.
 Note on the Discovery and Observations of Minor Planets (¹⁶⁰) to (¹⁶³). Mr. Dunkin.
 Note on Coggia's Comet (III. 1874). Mr. J. Dreyer.
 On the relative Power of Achromatic and Reflecting Telescopes. Dr. T. R. Robinson.
 Note on the Satellites of *Uranus*. Mr. E. Neison.
 Note on Dr. Royston Pigott's Starlit Transit Eyepiece. Capt. W. Noble.
 Visibility of *Oberon* and *Titania*. Mr. Rogerson.
 On Lohrmann's and Schmidt's Lunar Maps, and Note on a new red Star. Mr. J. Birmingham.
 Spectroscopic results for the Motions of Stars in the line of sight made at the Royal Observatory, Greenwich. The Astronomer-Royal.
 Note on the Displacement of Lines in the Spectra of Stars. Mr. W. H. M. Christie.
 On Precession. Dr. Berg.
 On the Transit across the Sun's disk of the second, or great Comet of 1819. Mr. J. R. Hind.
- June 9. On the Atmosphere of *Venus*. Mr. E. Neison.
 Remarks in connection with his five volumes of Solar drawings. Rev. F. Howlett.
 On the Determination of the Distances of a Comet from the Earth from three Observations. Dr. Berg.
 Visibility of *Mercury* and *Venus* in sunshine. Mr. W. F. Denning.
 Elements of Minor Planets (¹⁶¹), (¹⁶²) and (¹⁶³). Mr. Dunkin.
 On a hitherto unnoticed apparent inequality in the Longitude of the Moon. Prof. S. Newcomb.
 Photometric experiments upon the Light of *Venus*. Mr. J. I. Plummer.
 Observations of *Venus*. Capt. W. Noble.
 On the proper Motion of the bright Spots on *Jupiter*. Mr. J. Brett.
 Note on a method of obtaining Equatoreal Motion on an Altazimuth Stand. Lord Lindsay.
 Note on a Double Image Spectroscope. Lord Lindsay.

- Nov. 10. Measurement of the direct Effects of Sun-spots on Terrestrial Climates. Prof. Langley.
 Observations of Planets with the Transit Circle at Dublin (Dunsink). Dr. R. Copeland.
 Observations of Lunar Eclipse of 1876, September 3, made at Cadiz. Señor A. T. Arcimis.
 A method of deducing the Formula for correcting the Computed Time of an observed Occultation for errors in the Elements adopted. Mr. W. H. Finlay.
 Description of an Improved Altazimuth Stand for Reflecting Telescopes, with a new form of Binocular Eye-piece. Mr. W. H. Thornthwaite.
 Spectroscopic observations of the Motions of Stars and of *Venus* in the line of sight, and of the rotation of the Sun and of *Jupiter*, made at the Royal Observatory, Greenwich. The Astronomer-Royal.
 On the effect of wear in the Micrometer Screws of the Greenwich Transit Circle. Mr. W. H. M. Christie.
 Observations of the Solar Eclipse of 1876, Sept. 17. Mr. J. Tebbutt.
 An endeavour to simplify the method of making the correction for the Spheroidal figure of the Earth in Lunar observations, and particularly with reference to its effects upon the Lunar Distance. Mr. F. C. Penrose.
- Dec. 8. A List of Binary and other interesting Double Stars. Messrs. J. M. Wilson and J. Gledhill.
 On some phenomena of the Internal Contacts common to the Transits of *Venus*, observed in 1769 and 1874, and some remarks thereon. Mr. E. J. Stone.
 On some diffraction Experiments of M. Ch. André, with reference to Astronomical Instruments, and the general theory of this Diffraction. Rev. S. J. Perry.
 On the Phenomena exhibited by a Planet in its transit across the Solar disk, from observations by M. Ch. André. Rev. S. J. Perry.
 Note on the relative Space-penetrating power of the Pulkowa 15-inch Refractor, and Mr. Lassell's 4-foot Reflector. M. O. Struve.
 On an Oversight in the "*Mécanique Céleste*," and on the Internal Densities of the Planets. Mr. G. H. Darwin.
 On the Error of the tabular place of *Venus* on December 8, 1874. Col. Tennant.
 Note on the Gradation of Light on the disk of *Venus*. Mr. W. H. M. Christie.
 On the Position of the point of maximum brightness on *Venus*. Mr. E. Neison.

Note on Professor Langley's paper on the Direct Effects of Sun-spots on Terrestrial Climates. Mr. W. Mattieu Williams.

1877.

Jan. 12.

On the Orbit of *α Centauri*. Mr. A. Marth.

On the Conjunction of *Venus* and λ *Geminorum*. Mr. J. I. Plummer.

Theory of the Horizontal Photoheliograph, including its application to the determination of the Solar Parallax by means of Transits of *Venus*. Prof. Harkness.

On O. M. Mitchell's Observations at Cincinnati. Prof. Cleveland Abbe.

Observations of Shooting Stars, April to December, 1876. Mr. W. F. Denning.

Note on an Improved Mode of viewing the Sun. Dr. W. Erck.

Observations of Occultations of Stars by the Moon, and phenomena of *Jupiter's* satellites, made at the Royal Observatory, Greenwich, in the year 1876. The Astronomer-Royal.

Micrometrical Measures of Double Stars. Mr. G. Knott.

Ephemeris for determining the positions of the satellites of *Uranus*. Mr. A. Marth.

On the Orbit of *α Centauri*. Mr. J. R. Hind.

The Specular Reflection hypothesis, and its bearing on the Transits of *Venus*. Mr. J. Brett.

*List of Public Institutions and of Persons who have contributed to
the Society's Library &c. since the last Anniversary.*

Her Majesty's Government.
Her Majesty's Government in India.
Her Majesty's Government in Australia.
The Lords Commissioners of the Admiralty.
The Government of Prussia.
The Government of the United States of America.
The Meteorological Office.
Royal Society of London.
Royal Society of Edinburgh.
Royal Geographical Society.
Royal United Service Institution.
Royal Irish Academy.
Royal Dublin Society.
Royal Asiatic Society of Great Britain.
Royal Asiatic Society of Bombay.
Royal Society of New South Wales.
Royal Society of Tasmania.
Asiatic Society of Bengal.
Belfast Natural History and Philosophical Society.
British Association for the Advancement of Science.
British Horological Institute.
Council of the City of Manchester.
Geological Society.
Literary and Philosophical Society, Leeds.
Literary and Philosophical Society, Liverpool.
Literary and Philosophical Society, Manchester.
Philosophical Society, Glasgow.
Meteorological Society.
Photographic Society.
Physical Society of London.
Rugby School Natural History Society.
Society of Arts.
Zoological Society of London.
Royal Observatory, Greenwich.
Royal Observatory, Cape of Good Hope.
Radcliffe Observatory, Oxford.
Kew Observatory.
Imperial Observatory, Berlin.
Imperial Observatory, Vienna.
National Observatory, Paris.

Observatory, Cincinnati.
Observatory, Coimbra.
Observatory, Collegio Romano.
Observatory, Leyden.
Observatory, Madrid.
Observatory, Melbourne.
Observatory, Milan.
Observatory, Moncalieri.
Observatory, Munich.
Observatory, Prague.
Observatory, Strasburg.
Observatory, Sydney.
United States Naval Observatory, Washington.
Imperial Academy of Sciences, Berlin.
Imperial Academy of Sciences, St. Petersburg.
Imperial Academy of Sciences, Vienna.
Royal Academy of Sciences, Brussels.
Academy of Sciences, Paris.
Academy of Sciences, Amsterdam.
Academy of Sciences, Bologna.
Academy of Sciences, Buda-Pesth.
Academy of Sciences, Copenhagen.
Academy of Sciences, Göttingen.
Academy of Sciences, Montpellier.
Academy of Sciences, Munich.
Academy of Sciences, Stockholm.
Academy of Sciences, Turin.
Italian Society of Sciences, Rome.
Pontifical Academy de Lincei.
Society of Sciences, Batavia.
Society of Sciences, Bordeaux.
Society of Sciences, Cherbourg.
Society of Sciences, Helsingfors.
Society of Sciences, Leipsig.
Society of Sciences, Zurich.
Mathematical Society of France.
Museo Fisico, Florence.
Musée Teyler, Leyden.
Bureau des Longitudes.
Dépôt Général de la Marine.
Imperial University of Kasan.
Italian Spectroscopic Society.
Astronomische Gesellschaft, Leipsig.
Berlin Physical Society.
International Committee of Weights and Measures.
Smithsonian Institution, Washington.
American Academy of Sciences.
American Philosophical Society.
American Bureau of Navigation.
Franklin Institute, Philadelphia.

Canadian Institute.
 Connecticut Academy.
 Orleans County Society.
 Toronto Meteorological Office.
 Editor of the Athenæum.
 Editors of the American Journal of Science and Arts.
 Editor of the Astronomical Register.
 Editor of Bulletin des Sciences Mathématiques, &c.
 Editor of the English Mechanic.
 Editor of the Naturforscher.
 Editors of the Philosophical Magazine.
 Editor of the Quarterly Journal of Science.
 Editor of the Revue Scientifique.
 Editor of Sirius.
 Editor of the Telegraphic Journal.

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Dr. A. Abetti.	S. H. Miller, Esq.
Capt. W. de W. Abney.	Dr. C. G. Moesta.
Señor A. T. Arcimis.	Mons. J. A. Normand.
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S. M. Drach, Esq.	Sig. G. Tempel.
J. Dreyer, Esq.	C. Todd, Esq.
J. Ennis, Esq.	F. W. C. Trafford, Esq.
E. L. de Forest, Esq.	Mons. P. Tremaux.
P. Gray, Esq.	L. Trouvelot, Esq.
Mrs. Griesbach.	Capt. G. L. Tupman.
Mons. A. Guillemin.	Mons. E. Vicaire.
J. Herapath, Esq.	Dr. H. C. Vogel.
Lady Herschel.	Dr. A. Wagner.
Prof. E. S. Holden.	C. V. Walker, Esq.
Rev. F. Howlett,	T. Warner, Esq.
Mons. L. Hugo.	Rev. T. W. Webb.
Dr. Krueger.	Major-Gen. Worster.
S. P. Langley, Esq.	Dr. R. Wolf.
Lord Lindsay.	Prof. C. A. Young.
Sig. G. Luvini.	Prof. K. W. Zenger.

The Meeting then proceeded to the election of the Officers and Council for the ensuing year, when the following Fellows were elected :—

President.

WILLIAM HUGGINS, Esq., D.C.L., LL.D., F.R.S.

Vice-Presidents.

J. C. ADAMS, Esq., M.A., LL.D., F.R.S., Lowndean Professor of Astronomy, Cambridge.

Sir G. B. AIRY, K.C.B., M.A., LL.D., D.C.L., F.R.S., Astronomer-Royal.

ARTHUR CAYLEY, Esq., M.A., LL.D., F.R.S., Sadlerian Professor of Pure Mathematics, Cambridge.

EDWIN DUNKIN, Esq., F.R.S.

Treasurer.

SAMUEL CHARLES WHITBREAD, Esq., F.R.S.

Secretaries.

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A. COWPER RANYARD, Esq., M.A.

Foreign Secretary.

LORD LINDSAY, M.P.

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W. H. M. CHRISTIE, Esq., M.A.

WARREN DE LA RUE, Esq., M.A., D.C.L., F.R.S.

J. R. HIND, Esq., F.R.S., Superintendent of the *Nautical Almanac*.

E. B. KNOBEL, Esq.

GEORGE KNOTT, Esq.

WILLIAM LASSELL, Esq., LL.D., F.R.S.

E. NEISON, Esq.

Captain WILLIAM NOBLE.

REV. S. J. PERRY, F.R.S.

EARL OF ROSSE, B.A., D.C.L., F.R.S.

Captain G. L. TUPMAN, R.M.A.

ADDENDUM.

The Suspected Intra-Mercurial Planet.

The Astronomer Royal has requested me to append to the Annual Report of the Council the following letter recently received from M. Le Verrier, relating to the approaching possible conjunction of the supposed intra-Mercurial planet with the Sun on March 21, 22, and 23 next. It is of extreme importance that a *continuous* scrutiny of the solar disk should be kept up, both in the northern and southern hemispheres, during these three days, as after 1877 no other opportunity will be afforded for many years of observing a possible transit of the planet. The Sun's disk should therefore be watched for a small planet at every two hours or more on the three days mentioned above. Photographs should be obtained when practicable, as they are far preferable to eye-views.

E. DUNKIN.

PARIS: 15 *Février* 1877.

" MONSIEUR ET HONORÉ COLLÈGE,

" Vous n'aurez pas oublié qu'au commencement de l'automne dernier une discussion s'éleva des observations faites à diverses époques et attribuées aux passages d'une ou de plusieurs planètes sur le disque du Soleil.

" Après une élimination attentive des observations inconciliables, il fut reconnu que cinq observations pouvaient effectivement appartenir aux passages d'une planète sur le disque du Soleil, savoir :—

Fritsch	1802	Octobre 10
Decuppis	1839	Octobre 2
Sidebotham	1849	Mars 12
Lescarbault	1859	Mars 26
Lummis	1862	Mars 20.

(*Comptes Rendus de l'Académie*,
2 Octobre 1876, p. 649.)

" Il parut dès lors difficile d'admettre que des observateurs qui n'avaient eu aucune relation entre eux, ni aucune connaissance des périodes en discussion, fussent ainsi tombés par hasard sur cinq époques précises d'un phénomène explicable par le mouvement d'une même planète.

" Le savant directeur du *Nautical Almanac*, M. Hind, ajouta beaucoup à l'autorité de ces conclusions, en montrant qu'une sixième observation (Stark, 1819, Octobre 9) était également représentée par la même orbite. (*Comptes Rendus*, 30 Octobre 1876, p. 809.)

“ Les passages de la planète offrent des périodes comme tous les phénomènes du même genre.

“ Il a été établi qu'elle sera en conjonction avec le Soleil le 22 Mars prochain. Malheureusement les incertitudes qui règnent sur la position du nœud et la valeur de l'inclinaison ne permettent pas de décider si la planète passera précisément sur le disque du Soleil; et l'on peut même affirmer qu'après 1877 il s'écoulera plusieurs années avant qu'un passage soit possible. Dans cette situation, les astronomes estimeront, sans doute, qu'il importe d'observer très attentivement le Soleil les 21, 22 surtout, et 23 Mars prochain.

“ Veuillez agréer, Monsieur et honoré collègue, l'assurance de mes sentiments dévoués.

“ LE VERRIER.”

It may be remarked that telegrams on this subject have been forwarded by the Astronomer Royal to Dr. Hector, at Wellington, and to Dr. Haast, at Canterbury, New Zealand; to Mr. Ellery, at Melbourne; to Mr. Russell, at Sydney; to Mr. Todd, at Adelaide; and to Mr. Pogson, at Madras.

E. D.